STRATIGRAPHY OF THE CURRANT CREEK FORMATION
WASATCH AND DUCHESNE COUNTIES, UTAH

by

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## ABSTRACT

The Currant Creek Formation of Late Cretaceous to Early Eocene age is located on the northwestern flank of the Uinta Basin and on the southwestern flank of the Uinta Moutains. The Currant Creek unconformably overlies the Mesaverde Formation of Late Cretaceous age and unconformably underlies the Uinta (?) Formation of Early Eocene age. The age and correlation of the Currant Creek is based on previous work by Walton (1944 and 1964), Abott (1957), and Murany (1963 and 1964); field evidence, and subsurface information. Field evidence for correlation consists of unconformities, basal conglomerates, stratigraphic position, lithologic similarities to correlative formations, and conglomerate beds containing Upper Cretaceous fossils. Subsurface information consists of electric and lithologic log correlations by the writer, and structural contour mapping. The Currant Creek Formation is tentatively correlated with the Bennion Creek, North Horn, Flagstaff, and Colton Formations of the Wasatch Plateau; the Wasatch Formation of the Uinta Basin; and the Knight and Echo Canyon Formations of the Wasatch Plateau.

The Currant Creek Formation is a series of interbedded conglomerate, sandstone, siltstone, and shale. The lower part of the formation is predominantly sandstone and conglomerate and the upper part is mainly sandstone, siltstone, and shale. Individual rock units are composed of lithic (petromict)

boulder, cobble, pebble, and granule conglomerates, orthoquartzite to subgraywacke sandstones, siltstones, and sandy-silty-calcareous shales.

The formation ranges from about 4,800 feet thick in the Currant Creek area to about 4,000 feet thick in the Red Creek area, and in the Duchesne River-Little Valley areas it thins to 1,500 feet thick. The formation pinches out eastward from Little Valley.

Three erosional pediment surfaces are developed in the area and are correlated, from oldest to youngest, with decreasing elevation, to the Lake Mountain, Jensen, and Vernal or Thornburg surfaces described in the Vernal, Utah area by Kinney (1955).

The term Uinta Basin Fault is proposed for a subsurface fault that trends northeast-southwest and roughly follows the trace of the Uinta Basin axis. The fault is believed to be a thrust fault.

Bituminous sandstone deposits are present in the Duchesne River-Little Valley area in the Uinta (?) and Currant Creek Formations and offer some potential for future economic development.

CONTENTS

ILLUSTRATIONS

| Figure | | Page |
|---|---|---|

Table | Page



Plate | Page

# INTRODUCTION

## Purpose and Scope

The purpose of this report is to define the Currant Creek Formation of Cretaceous-Tertiary age, to discuss its stratigraphic and structural setting and to correlate it with other units. In accomplishing these objectives the writer prepared a geologic map of the formation, delimiting its upper and lower boundaries (pl. 1), and two stratigraphic sections were measured (App. A and B; and pl. 2). The geology of the formation, that is its geography and physiography, stratigraphy, structure, tectonic history, and economic geology, are discussed in detail. Highlights of the report are given in the summary presented in the last section.

## Previous Work

The Currant Creek Formation has not been studied in detail in its entirety by any single author but has been treated briefly in reports encompassing larger areas. Its location on the southwest flank of the Uinta Mountains brings it into the realm of many early regional geologic and geographic studies as well as many recent geologic studies.

The earliest geographic explorations through the Uinta Mountains region included Fremont (1842, 1843, and 1844), Simpson and Englemann (1859 and 1876), and Jones (1872). Early geologic work in the region included that of Powell (1876, King, and others (1877), Berkey (1904 and 1905), Atwood (1907, 1908, and 1909), Emmons (1907), Weeks (1907), Lupton (1912), and Schultz (1918).

Since these early reports many papers have been published on the Uinta Mountains and the Uinta Basin. The papers closely related to the problem are those by Forrester (1937), Walton (1944), Huddle and McCann (1947), Williams (1950), Huddle, Mapel, and McCann (1951), Bissell (1952 and 1959), Stokes and others (1955), Walton (1957 and 1964), Abbot (1957), Murany (1963 and 1964), and Hale and Van De Graaff (1964).

## Methods of Study

### Field Methods

Field mapping was done on aerial photographs at a scale of 1:20,000 and the results transferred by inspection to U. S. Geological Survey topographic maps at a scale of 1:24,000. In many instances geologic contacts of the Currant Creek Formation were drawn on vegetational or erosional forms visible on the aerial photographs because good exposures of the formation were missing.

Mapping by vegetaional control was very useful and a good substitute where actual outcrops are obscured. Bedding in the upper Mesaverde Formation tends to cause plants to grow in rows along the upturned edges of bedding. Bedding in the lower Currant Creek is virtually nonexistent, due to thick conglomerate and sandstone units at the base of the formation, causing plants to grow in a disarranged fashion. The influence of plant growth by bedding control was also a good indicator for choosing the base of the Currant Creek Formation where outcrops were poorly exposed.

Aerial photo and field mapping on erosional control consisted of drawing contacts between nonresistant and resistant beds. The non-resistant beds of the Currant Creek Formation form low areas against the more resistant beds of the Mesaverde Formation. Examination of photos was supplemented by field mapping.

Sections of Currant Creek Formation were measured by three methods: (1) the Jacob staff, (2) the Brunton compass, and (3) the Brunton compass and 100-foot tape methods. Most of the sections were measured with a Jacob staff, however.

## Rock and Textural Classifications

Rock and textural classifications used in the field and throught this report are those classifications proposed by Wentworth (1922), Shepard (1954), and Pettijohn (1957). The size grade classification is from the Wentworth grade scale (1922), classification of sand, silt, and clay mixtures is from Shepard (1954), and classification of conglomerates and sandstones is from Pettijohn (1957).

## GEOGRAPHY AND PHYSIOGRAPHY

### Location and Accessibility

Regionally, the area involved in this paper is located in the Uinta Basin section of the Colorado Plateau Geographic Province. The area is bordered on the north by the southern flank of the Uinta Mountains, on the east by the north central Uinta Basin, on the south by the west central Uinta Basin, on the west by the Wasatch Mountains, and on the northwest by the junction of the Wasatch and Uinta Mountains. Locally, outcrops of Currant Creek Formation are found about 50 miles southeast of Heber and 40 miles northwest of Duchesne in lat $42^{\circ}$ 22' N.; long $110^{\circ}$ 30' to $111^{\circ}$ 07' W., and in Tps. 1 and 2 S., Rs. 7, 8, 9, 10, and 11W., Uinta Special Meridian, Wasatch and Duchesne Counties, Utah (fig. 1).

The area is accessible by numerous unimproved roads from U. S. Highway 40 and State Highways 35 and 208. The unimproved roads are primarily for 4-wheel drive vehicles only.

Main access to the Currant Creek outcrop area from U. S. Highway 40 is by unimproved roads along Co-op Creek, Trout Creek, Currant Creek, and Red Creek. The Tabiona area may be reached from U. S. Highway 40 via State Highways 35 and 208 and then by unimproved roads which depart from State Highway 35 (fig. 1 and pl. 1).

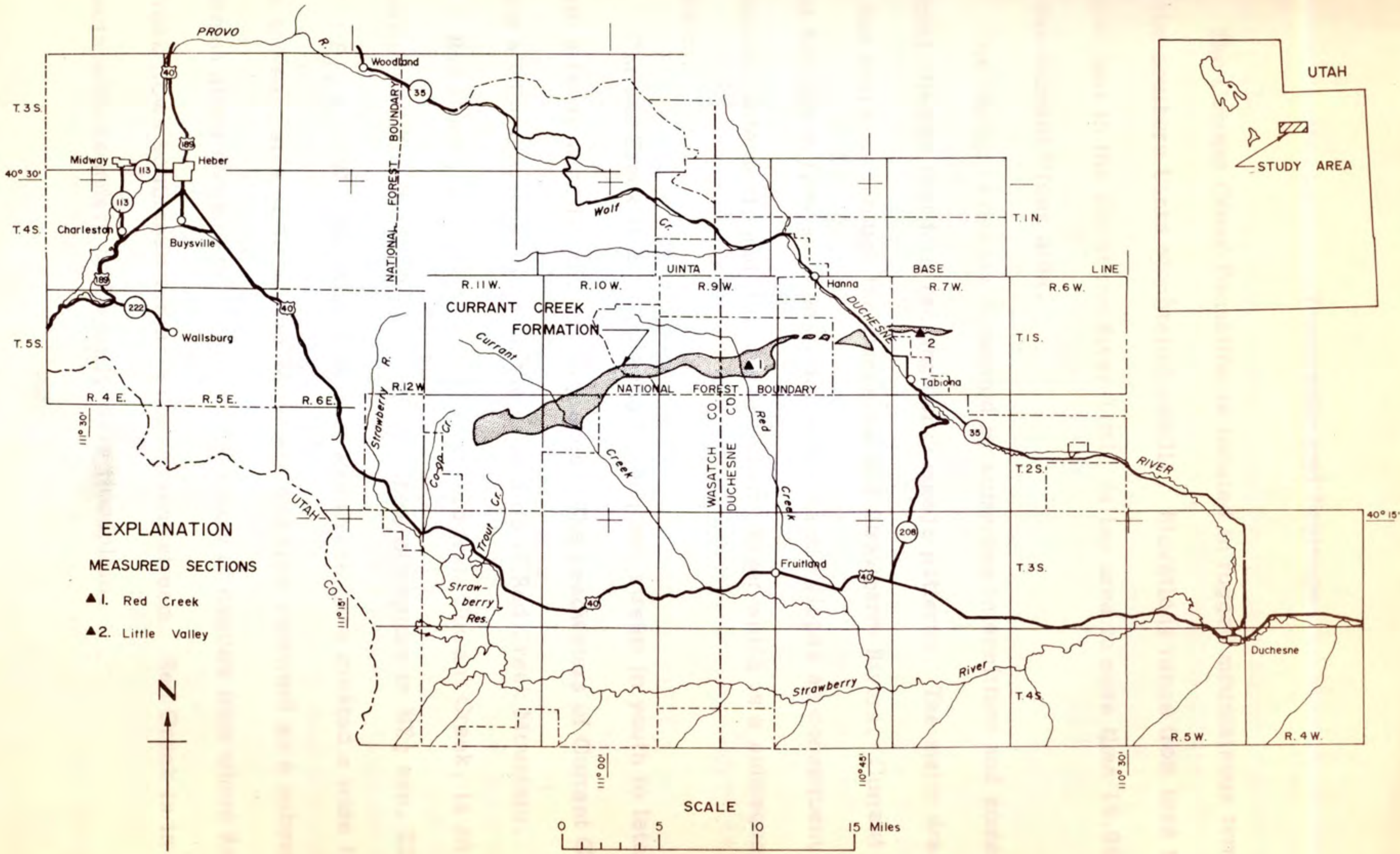



Figure I. Index map of study area illustrating outcrops of Currant Creek Formation (stippled) and location of measured Sections.

## Topography and Drainage

The Currant Creek Formation is located in rugged mountainous terrain of the southern Uinta Mountain foothills. Elevations range from less than 7,000 feet in the Duchesne River-Little Valley area to more than 10,000 feet in the Currant Creek area.

The region is deeply dissected by numerous intermittant and some perennial streams that form rectangular drainage patterns. The major drainage of the region is through the Duchesne and Strawberry Rivers. Currant Creek and Red Creek flow southeastward down the dip slopes as consequent streams, intersect, and join the Strawberry River which is a subsequent stream.

Currant Creek is a meandering consequent stream in youth to late youth with a fairly wide flood plain in places. The headwaters of Currant Creek form a wide drainage basin on the west side of Red Creek Mountain.

Red Creek, across the divide eastward from Currant Creek, is an example of a captured stream with an elbow of capture in NE$\frac{1}{4}$ sec. 22, T. 1 S., R. 9 W. The headwaters of Red Creek have created a wide basin on the east side of Red Creek Mountain and flow eastward as a subsequent stream along nonresistant shale to the elbow of capture from where Red Creek flows southeastward as a consequent stream. Red Creek is in late youth with meanders and a fairly wide floodplain.

The Duchesne River has its headwaters several miles north of the mapped area. It is an early mature, meandering, consequent stream with a wide floodplain. It has been rejuvenated and, in some places, has steep cliffs along its banks, dissecting a glacial-fluvial fan is secs. 9, 10, 14, and 15, T. 1 S., R. 8 W.

## Climate and Vegetation

The climate is generally semi-arid and because of the high elevations the area is subject to heavy winter snowfalls and frequent summer thunder-showers. High annual precipitation from less than 16 inches to more than 30 inches (Utah Engr. Office and others, 1960) allows for a heavy cover of grasses, shrubs, sagebrush, and aspen forests.

## Glacial Features

The glacial geology of the high Uinta Mountains has been described by Atwood (1907 and 1909), and by University of Utah students working on thesis projects in smaller areas. Some mention of the glaciation is necessary for this study area, however, because glacial deposits cover some of the outcrops.

Three small cirque basins created by Pleistocene glaciation are present on Tabby Mountain in secs. 20 and 21, T. 1 S., R. 8 W. Extending north-eastward from the cirques is a large glacial-fluvial fan that has been truncated by the Duchesne River. Several small alluvial fans have formed along the dissected edge of the larger fan and have spread out onto the Duchesne River floodplain.

## Landslides

Landslides are a common geomorphic feature of the Currant Creek Formation and are discussed because they cover some local outcrops of Currant Creek Formation. Three landslides are shown on plate 1. The largest of the landslides is a classic feature. It is adjacent to Currant Creek in Red Ledge Hollow in secs. 4, 5, and 8, T. 2 S., R. 10 W. The slide is more than two miles long and one-half mile wide at its widest dimension. It has forced a rerouting of Currant Creek around it to form a steep, almost inaccessible, gorge. A detailed geomorphic study of the slide has been prepared by Schroder (1967). Two smaller landslides are in Bear Hole Hollow in secs. 27, 33, and 34, T. 1 S., R. 10 W.

## Pediment Surfaces

Pediment surfaces are well developed throughout the mapped area and are discussed because they are present in the mapped area. Correlation of these surfaces with other known pediment surfaces is a problem because of the long distances between other studied pediments and the area involved in this report.

Bradley (1936, p. 169), recognized four erosion surfaces on the north flank of the Uinta Mountains. From oldest to youngest, with descending elevation, these surfaces are the Gilbert Peak, Bear Mountain, Tipperary, and Lyman surfaces. Kinney (1955, p. 126-130) recognized five major erosional surfaces on the south flank of the Uinta Mountains in the Uinta River-Brush Creek area, Duchesne and Uinta Counties, Utah. From oldest to youngest, with descending elevation, these surfaces are the Gilbert Peak, Lake Mountain, Jensen, Vernal strath, and the Thornburg strath surfaces.

Three erosional surfaces are present in the mapped area. The highest and oldest surface forms the tops of Racetrack Peak, Red Creek Mountain, Raspberry Knoll, Bobby Duke Ridge, Tabby Mountain, and Dry Mountain (Dry Mountain lies immediately east of the mapped area). These surfaces, with the exception of the surface on Racetrack Peak, are covered with the Bishop Conglomerate, a Tertiary deposit that was deposited on the surface. The surface on Racetrack Peak has no covering of Bishop Conglomerate. The Bear Mountain surface of Bradley and the Lake Mountain surface of Kinney are also developed below the Bishop Conglomerate. These terraces characteristically are expressed as the tops of round table-top mountains that are at nearly the same elevation (figs. 2 and 3, and pl. 1). On this basis then, a tentative correlation is made to the Bear Mountain and Lake Mountain surfaces and the uppermost pediment terrace is tentatively referred to the Lake Mountain surface. The map symbol Tb represents the Bishop

Conglomerate on plate 1.

Approximately 1,760 feet below the Lake Mountain pediment surface is another less extensive terrace that is well developed along Currant Creek. Another pediment surface, about 40 to 50 feet below the surface in Currant Creek, is developed near Tabiona just east of State Highway 35 in secs. 13 and 18, T. 1 S., R. 7 and 8 W. Here the surface is covered with a thin veneer of cobble gravel from 5 to 20 feet thick with some caliche coating the gravels. The veneer of gravel is missing from the surface in the Currant Creek area. A similar deposit covers the Jensen surface of Kinney. The pediment terrace in the study is tentatively correlated with the Jensen surface. This terrace is given the symbol Qgs on plate 1.

Along Currant Creek and Racetrack Creek, about 240 to 250 feet below the Jensen surface, is a strath terrace (located about 80 feet above stream level) that grades upstream into present floodplains. This terrace may correlate with the Vernal or Thornburg strath surfaces of Kinney. The map symbol Qgs is assigned to this terrace (fig. 4 and pl. 1).

Long distance correlations such as those just proposed are tentative and further use of the nomenclature presented herein should await mapping between the study area and the Uinta River-Brush Creek area of Kinney.

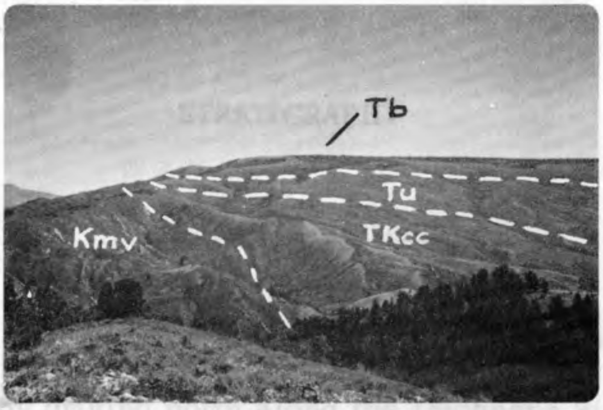



Figure 2. Photograph looking eastward toward Tabby Mountain showing the flat-topped mountain and the stratigraphy of the area

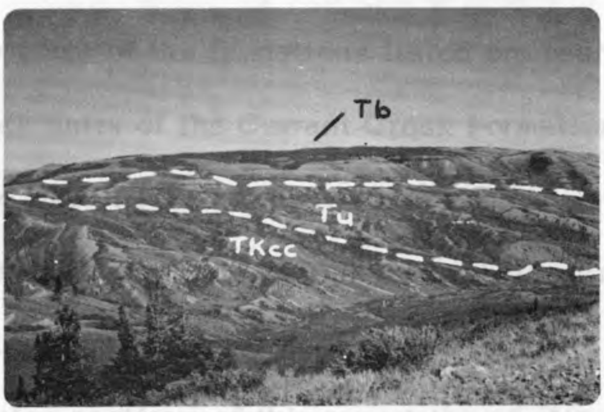



Figure 3. Photograph looking eastward toward Tabby Mountain showing the flat-topped mountain and the stratigraphy of the area. Note angular unconformities between the Currant Creek and Uinta (?) and the Uinta (?) and Bishop.


Figure 4. Photograph looking west across Currant Creek and up Racetrack Creek showing stratigraphy and strath terrace (Qgs).

# STRATIGRAPHY

## General Statement

Most of the geologic section of the Uinta Basin and Uinta Mountains area may be seen by driving north along the Duchesne River on State Highway 35 where rocks from Precambrian to Recent age are exposed. A generalized geologic column of the Uinta Basin and Uinta Mountains is given in table 1 because some of the formations listed are represented by rock particles in the rock units of the Currant Creek Formation.

The rocks exposed in the Uinta Basin are primarily Tertiary in age. These rocks display series of lateral and vertical lithologic changes to create an interesting study area for geologists.

In the following sections of this report the stratigraphy of the Currant Creek Formation is presented. General descriptions of the underlying Mesaverde and the overlying Uinta (?) Formations, as well as the Bishop Conglomerate, are also given because they constituted a part of the field work and resulting geologic map (pl. 1 in pocket).

Also included under stratigraphy are sedimentary textures and structures, reworked fossils, provenance and origin, and age and correlation of the Currant Creek Formation.

Table 1. Generalized Stratigraphic Section of Uinta Mountains
Uinta Basin Area

| Period | Epoch or Series | Group or Formation | Member | Lithologic Description | Thickness (feet) |
|---|---|---|---|---|---|
| Quaternary | Recent | Alluvium | | Stream alluvium, slope wash, talus, and landslide debris. | 0-150 |
| | Pleistocene | Gravel Deposits | | Glacial-fluvial, pediment and fan gravels. | 0-250 |
| Tertiary | Pliocene | | | | |
| | Miocene | Bishop Conglomerate | | Conglomerate; red to grayish-white; generally loosely consolidated; contains boulders from many older formations. | 0-100 |
| | Oligocene ? | Andesite Tuff and Breccia | | Volcanic tuff and breccia. | 1000-1500 |
| | Eocene | Uinta Formation | | Conglomerate, sandstone, mudstone, siltstone and shale; gray to white; variegated; interbedded; channels. | 4500 |
| | | Green River Formation | Evacuation and Parachute Creek Members | Shale, oil shale, siltstone, sandstone, and limestone; variegated colors, divided into several members | 1800-2400 |
| | | | Delta Facies | | |
| | | | Basal Member | | |

Table 1.

| Period | Epoch or Series | Group or Formation | Member | Lithologic Description | Thickness (feet) |
|---|---|---|---|---|---|
| Tertiary | Eocene | Wasatch Formation | | Conglomerate, sandstone, siltstone, and shale, light gray to reddish brown, interbedded, thin- to thick-bedded. | 780 |
| | Paleocene | Currant Creek Formation | | Conglomerate, sandstone, and siltstone, some shale; light gray to yellowish brown; interbedded; conglomerate lower part; sandstone and siltstone upper part. | 4000 |
| Cretaceous | Upper Cretaceous | Mesaverde Formation | | Sandstone; light gray; with some interbedded shale and coal; very fine- to coarse-grained; crossbedded; massive; marine lower part; mostly nonmarine | 550-4000 |
| | | Mancos Shale | Upper Shale Member | Shale; gray; clayey; calcareous; interbeds of thin sandstone. | 1680-2200 |
| | | | Frontier Sandstone Member | Sandstone; light gray to yellowish-brown; fine- to coarse-grained; thin- to thick-bedded; crossbedded; thickens westward; coal bearing in upper part. | 500-660 |
| | Lower Cretaceous | Mowry Shale | | Shale; gray; siliceous; waterlaid volcanic ash; contains fish scales. | 85-300 |
| | | Dakota Sandstone | | Sandstone; gray; contains interbedded conglomerate; black | 30-40 |

Table 1.

| Period | Epoch or Series | Group or Formation | Member | Lithologic Description | Thickness (feet) |
| --- | --- | --- | --- | --- | --- |
| Cretaceous | Lower Cretaceous | | | chert pebbles; fine- to coarse-grained. Thick- to very thick-bedded. | |
| | | Cedar Mountain Formation | Cedar Mountain Member | Mudstone, green, purple and reddish-brown; calcareous, many nodules | 100-150 |
| | | | Buckhorn Member | Conglomerate and conglomeratic mudstone with gray, black, and pink chert pebbles. | 20-50 |
| Jurassic | Upper Jurassic | Morrison Formation | | Shale, sandstone, siltstone, and conglomerate with some fresh-water limestone; calcareous. | 1100-1550 |
| | | Curtis-Stump Formation | | Sandstone, shale, and oolitic limestone; greenish gray. | 100-725 |
| | | Entrada-Preuss Sandstone | | Sandstone; dark red; fine-grained; contains minor amounts of shale and mudstone. | 700-1585 |
| | Middle Jurassic | Twin Creek Limestone | | Limestone; dark to light gray; locally oolitic; fossiliferous; shaly; brittle. | 700-950 |
| | Lower Jurassic | Nugget Sandstone | | Sandstone; light red to white; fine- to medium-grained; grains frosted; high angle crossbedding. | 1100-1240 |

Table 1.

| Period | Epoch or Series | Group or Formation | Member | Lithologic Description | Thickness (feet) |
|---|---|---|---|---|---|
| Triassic | Upper Triassic | Chinle Formation | | Mudstone, siltstone, and shale; interbedded with argillaceous shale; variegated. | 250-485 |
| Triassic | Middle ? Triassic | Shinarump (or Gartra) Formation | | Sandstone; gray to white; locally conglomeratic; cross-bedded; massive. | 35-125 |
| Triassic | Middle ? Triassic | Moenkopi Group: Ankareh Shale | | Shale and siltstone, variegated. | 800-1550 |
| Triassic | Lower Triassic | Moenkopi Group: Thaynes Limestone | | Limestone and shale; grayish-brown; interbedded sandstone; fossiliferous. | 550-1530 |
| Triassic | Lower Triassic | Moenkopi Group: Woodside Shale | | Siltstone and shale; reddish-brown. | 400-1000 |
| Permian | Guadalupian | Park City Formation | | Dolomitic limestone, black phosphatic shale, and sandstone; contains nodules of black chert; fossiliferous. | 350-450 |
| Pennsylvanian | Virgilian<br>Missourian<br>Desmoinesian | Weber Quartzite | | Quartzite; gray to light gray; very fine-grained; calcareous; massive-bedded. | 1200-1600 |
| Pennsylvanian | Atokan | Morgan Formation | | Limestone, shale, and sandstone; light gray to brown; interbedded; limestone contains black chert nodules. | 250 |
| Pennsylvanian | Morrowan<br>Springeran | Round Valley Formation | | Limestone; light gray; contains chert nodules. | 500 |

Table 1.

| Period | Epoch or Series | Group or Formation | Member | Lithologic Description | Thickness (feet) |
|---|---|---|---|---|---|
| Mississippian | Chesterian | Doughnut Formation | | Shale; black; calcareous; interbedded with thin beds of limestone and sandstone. | 500 |
| | Meramecian | Humbug Formation | | Limestone breccia, sandstone breccia, and limestone; light gray to brown. | 350-400 |
| | Osagian | Deseret Limestone | | Limestone and dolomitic limestone; light to dark gray; abundant black chert in nodules and thin lenses; fossiliferous. | 600-650 |
| | Kinderhookian | Madison Limestone | | Limestone; dark gray; dolomitic in part; abundant black and gray chert; shale partings between beds. | 240-500 |
| Cambrian | Albertan | Tintic Quartzite | | Quartzite; light yellow brown to greenish gray; fine- to coarse-grained; pebbles and granules along bedding; cross-bedded. | 400-500 |
| Younger Pre-Cambrian | Big Cottonwood Series | Uinta Mountain Group: Red Pine Shale | | Shale; greenish gray to black; sericitic; micaceous; interbeds of yellowish-brown arkosic sandstone. | 3000 |
| | | Uinta Mountain Group: Mutual Quartzite | | Quartzite; reddish purple; arkosic; shale lenses 200 to 400 feet thick. | 4000 |
| | | Uinta Mountain Group: Undivided | | Quartzite, sandstone; white, dark red and gray; siliceous; interbeds of conglomerate, shale, and argillite; cross-bedded. | 5000-8000 |

Table 1.

| Period | Epoch or Series | Group or Formation | Member | Lithologic Character | Thickness (feet) |
|---|---|---|---|---|---|
| Older Pre-Cambrian | | Undivided | | Schists; quartzitic; sericitic; quartz biotite; and chloritic; contains mafic dikes; amphibolites. | ? |

Compiled after Walton (1944), Huddle and McCann (1947, Bissell (1952), Stokes (1955), Abbott (1957), Hansen (1957), Sadlick (1957), Stokes (1957), Walton (1957), Williams (1957), Cohenour (1959), Crittenden (1959), Lochman-Balk (1959), Sadlick (1959), Scott (1959), Bissell (1964), Hale and Van de Graaff (1964), Murany (1964) and Moussa (1966).

## Mesaverde Formation

The Mesaverde Formation of Upper Cretaceous age consists of sandstone with some interbedded shale and coal. The Mesaverde extends throughout the mapped area and is topographically expressed as a hogback ridge. Bissell (1952, p. 611) measured 5,165 feet of Mesaverde in the Currant Creek basin area; Walton (1944, p. 106-107) measured about 3,000 feet of Mesaverde in the Red Creek area; and Huddle and McCann (1947) measured 1,700 feet of Mesaverde west of the Duchesne River and 550 feet of Mesaverde east of the Duchesne River. Huddle, Mapel, and McCann (1951) measured about 1,700 feet of Mesaverde near Dry Mountain which lies immediately east of the mapped area. The formation thins eastward from Currant Creek basin because of an unconformity between the Mesaverde and the overlying Currant Creek Formation.

The Mesaverde is mainly sandstone; white; gray to yellowish-brown in color; is very fine- to coarse-grained with subangular to rounded quartz grains with calcareous cement. The sandstones are orthoquartzite to subgraywacke in composition with some black chert pebbles included. The beds are massive and contain small scale, low-angle cross-bedding. Thin beds of shale and coal are common near the top of the Mesaverde in Currant and Red Creeks.

The Mesaverde dips steeply southward throughout the mapped area with dips from less than $30^{\circ}$ to more than $50^{\circ}$. The formation lies disconformably below the Currant Creek Formation with little or no discordance of dip.

In Currant and Red Creeks the contact with the Currant Creek is taken at the first occurrence of basal conglomerates overlying Mesaverde sandstones and at the change in slope between the more resistant Mesaverde and the less resistant Currant Creek. In the Duchesne River-Little Valley area, however, the Currant Creek contact is chosen at the first appearance of graded bedding up-section from the Mesaverde and at the change in slope between the Mesaverde and the Currant Creek.

## Currant Creek Formation

### General Description

The Currant Creek Formation was named by Walton (1944, p. 117) for "the sequence of conglomerates, sandstones, and variegated shales which, in the western part of the Uinta Basin, transect (overlie unconformably R.F.G.) the Mesaverde ... beds and unconformably underlie the Eocene strata of probable Uinta age."

The Currant Creek is a series of interbedded conglomerates and sandstones with some beds of siltstone and shale. The conglomerates are lithic (petromict) conglomerates with frameworks of boulders, cobbles, pebbles, and granules, but predominantly cobbles. (Conglomerates are made up of framework and voids according to Pettijohn, 1957, p. 245.)

The conglomerates are generally gray to light gray in color, and are composed primarily of quartzite from the Pennsylvanian Weber Quartzite, Precambrian Mutual Quartzite, black Paleozoic chert, and minor amounts of limestone. The fragments are generally rounded but become more angular with decreasing size. The conglomerates predominate in the lower part of the Currant Creek. The sandstones are light gray to light yellow or yellowish-brown in color; are poorly to well sorted; contain subangular to rounded grains; and are loosely to tightly cemented with calcareous cement. The sandstones range in composition from subgraywacke near the base of the formation to orthoquartzite near the top of the formation. The beds are lenticular, blanket, or wedge shaped. Most of the sandstone tongues or wedges pinch out westward. The sandstones predominate the upper section of the Currant Creek. Siltstones and shales are reddish-brown to variegated in color, calcareous, and poorly exposed. Bentonite may be interbedded in places and weathers to "popcorn" surfaces. Throughout the formation the units are thin- to massive-bedded and some contain small scale, low angle cross-bedding. Detailed descriptions of individual units are given in Appendices A and B.

The Currant Creek unconformably overlies the Mesaverde Formation of Upper Cretaceous age and unconformably underlies the Uinta (?) Formation of Eocene age.

The base of the formation in Red and Currant Creeks was drawn at the base of a cobble-boulder conglomerate sequence that, in places, forms a fairly resistant ridge. In the Duchesne River-Little Valley area the base of the formation was taken at the first graded sandstone unit above the Mesaverde sandstones and at the change in slope between the more resistant Mesaverde and the less resistant Currant Creek. In contrast, the lower contact throughout the study area is very difficult to choose and was determined for map purposes by erosional and vegetational control (fig. 5).

The top of the Currant Creek was drawn, throughout the study area, at the base of a steep prominant slope formed by the overlying Uinta (?) Formation. The Uinta (?) is characteristically a red to brownish-red cobble conglomerate, where it is exposed near the contact, containing a framework of cobbles derived from many previous geologic systems. Nowhere in the mapped area, however, is the actual upper contact exposed.

The Currant Creek Formation generally forms an outcrop pattern of low relief in comparison with the more resistant ridges of the Mesaverde and Uinta (?) Formations. The lower part of the formation forms a steep ridge in the Currant Creek area but is otherwise fairly subdued in relief. The upper part of the formation forms a low hummocky type of topography in the Currant Creek and Red Creek areas.


Figure 5. Photograph showing lower boundary of Currant Creek in Red Creek. Note change in vegetation along contact.

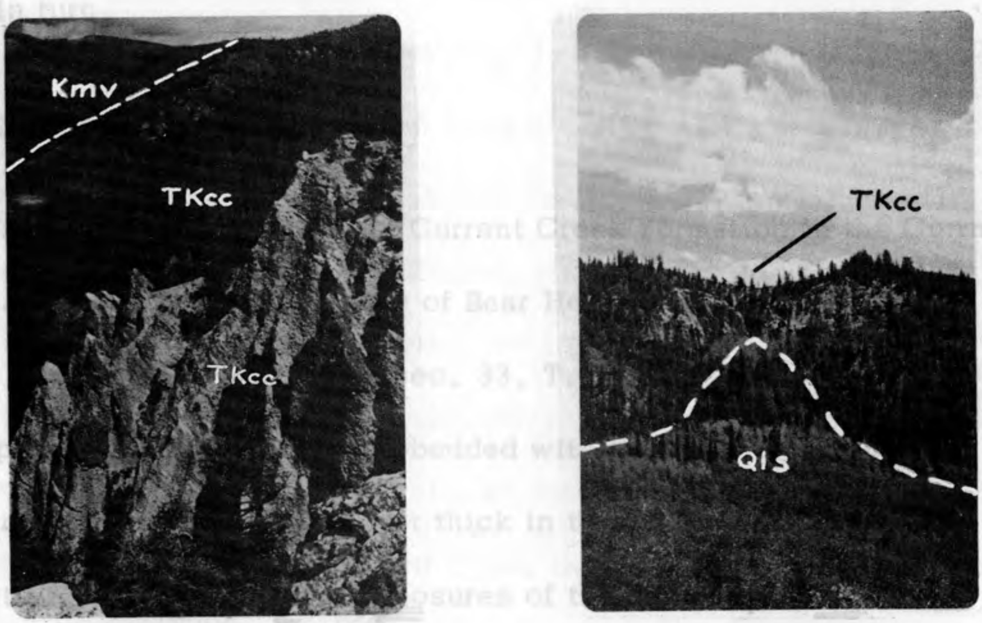



Figure 6. Photographs of conglomerate outcrops on White Ledge. Note steep south dips in left photo. Also note landslide (Qls) in right photo.

The unconformity at the top of the Currant Creek Formation has removed most of the upper part of the formation eastward and is responsible for the rapid thinning of the formation east of the Duchesne River.

Conglomerates of the lower Currant Creek Formation in Currant and Red Creeks show a rapid decrease in particle size eastward from Red Creek to pebble and granule conglomerates in the Duchesne River-Little Valley area.

Exposures of the Currant Creek may be found, from west to east, in the Currant Creek, Red Creek, and Duchesne River-Little Valley areas. The following discussion of the formation covers each of these areas in turn.

## Currant Creek Area

The best exposures of the Currant Creek Formation in the Currant Creek area are on the south side of Bear Hole Hollow on the north facing slope of White Ledge in sec. 33, T. 1 S., R. 10 W. These outcrops are conglomerates interbedded with thin sandstone lenses. The sequence is about 1,000 feet thick in this area. Figures 6 and 7 illustrate these outcrops. Exposures of the conglomerate grade eastward into thick sandstone channel deposits in the NE$\frac{1}{4}$ of sec. 33.

Other outcrops of Currant Creek in the Currant Creek area are scarce and scattered and are mostly small and poorly exposed. In the SE$\frac{1}{4}$ sec. 6 and the NE$\frac{1}{4}$ sec. 7, T. 2 S., R. 10 W., along the south facing slope of a long ridge, are exposures of conglomerate columns (figs. 9 and 14). On the north side of Racetrack Creek, near the top of a high ridge in the NW$\frac{1}{4}$ sec. 11, T. 2 S., R. 11 W., is a small outcrop of cobble gravel weathering from the underlying conglomerate beds.

All of the outcrops in the Currant Creek area are conglomerates interbedded with thin channels or tongues of sandstone (fig. 7). The predominantly lithic (petromict) cobble conglomerates consist of a framework of Weber Quartzite, Mutual Quartzite, and black Paleozoic chert. The beds, and particles within the beds, are generally aligned and imbricated northwest. Graded bedding is well developed in the conglomerate units. Interbedded thin sandstone lenses and beds are less than a few inches to more than five feet thick. Poorly developed small scale, low angle cross-bedding is a feature of the sandstones.

The lower contact of the formation in the Currant Creek area was chosen at the base of the conglomerate beds described above. In areas where these beds were not exposed the contact was drawn arbitrarily by erosional and vegetational control. The Currant Creek overlies the Mesaverde with angular unconformity in the western part of the area and in Racetrack Creek truncates a syncline formed in the Mesaverde. Eastward the limbs of the

Figure 7. Photograph of Currant Creek outcrop on White Ledge. Note channel sandstone that overlies conglomerate unit.


Figure 8. Photograph of Red Ledge showing upper contact of Currant Creek with the Uinta (?). Note steep Uinta (?) slope.

syncline straighten out and the contact becomes disconformable and identification of the basal Currant Creek is virtually impossible because of uniformity of dip on either side of the contact and dense vegetational cover.

The upper boundary was drawn westward from the base of Red Ledge along the base of the steep Uinta (?) slope (fig. 8). Nowhere along the contact are any rocks exposed.

Dips within the Currant Creek range from about $50^{\circ}$ south near the base of the formation to about $5^{\circ}$ south near the top of the formation. Figure 9 illustrates diversity of dips in a single outcrop ranging between $40^{\circ}$ to $55^{\circ}$ south.

Because of the scarcity of outcrops in the Currant Creek area a complete measured section is not possible. Several partial sections were measured but are not listed in the Appendices because their stratigraphic position within the Currant Creek is uncertain. Bissell (1952, p. 614) estimated the Currant Creek to be about 4,800 feet thick in this area.

A generalized geologic section is given on plate 1 (in pocket).

<u>Red Creek Area</u>

The best exposures of the Currant Creek Formation are in Red Creek (pl. 1 and App. A). The formation is well exposed in secs. 26, 27, and 35, T. 1 S., R. 9 W. An aggregate thickness of 3,940 feet of Currant Creek

Figure 9. Photograph of conglomerate column on White Ledge showing diversity of dip of from $40^{\circ}$ to $55^{\circ}$ south.

Figure 10. Panoramic view along east side of Red Creek showing yellowish-brown sandstone and conglomerate units in left center of photograph. The yellowish-brown sandstones and conglomerates are composed of material weathered from Cretaceous rocks.

was measured along the east side of Red Creek. The lower 2,100 feet is predominantly conglomerate with interbedded sandstone and the upper 1,840 feet is predominantly sandstone and siltstone or shale slopes.

The conglomerates are predominantly lithic (petromict) cobble conglomerates similar to those conglomerates described in the Currant Creek area. They are interbedded with tongues, lenses, and tabular beds of sandstone and finer-grained conglomerates. For the most part, the conglomerate beds are gray to light gray with frameworks composed mainly of Weber Quartzite cobbles with some Mutual Quartzite and Paleozoic black chert cobbles and pebbles. The Mutual quartzite makes up about 5% of the framework material and the black cherts make up about 10% of the framework. The beds are very thin- to massive-bedded and some of the sandstone units exhibit small scale, low angle cross-bedding. Alignment of framework particles is generally well developed with the particles being aligned and imbricated northwest. The sandstones are subgraywacke and orthoquartzite in composition and are texturally similar to sandstone lenses in the conglomerates in the Currant Creek area. Most of the sandstone units pinch out westward. Graded bedding is well developed in some of the conglomerate and sandstone units.

Units 35 to 58 of measured section number one (App. A) are a series of interbedded light yellowish- to yellowish-brown sandstones and conglomerates about 526 feet thick (fig. 10). The conglomerates contain boulders, cobbles, and pebbles. The boulders and some of the cobbles are composed of Cretaceous Frontier Sandstone (fig. 10). A large oyster-bearing boulder was found resting on top of unit 35 in this section (fig. 11). The predominant yellowish color of the section is probably derived from the yellowish-brown sandstones of the Cretaceous Frontier Sanstone and possibly the Cretaceous Mesaverde Formation.

The base of the Currant Creek in this area was chosen at the base of a cobble conglomerate which has been stained with reddish-brown limonite. The conglomerate is poorly exposed but may be found along the road in Red Creek and in scattered localities eastward into the SE$\frac{1}{4}$ sec. 17, T. 1 S., R. 8 W., (fig. 14). The contact between the Mesaverde and the Currant Creek is probably disconformable and was drawn mainly on topographic expression between the more resistant Mesaverde and the less resistant Currant Creek (figs. 2 and 5). Westward, the lower contact is very difficult to determine. The basal conglomerate bed extends into the SE$\frac{1}{4}$ sec. 21, T. 1 S., R. 9 W., but westward beyond this the contact was inferred and drawn on topographic and vegetational control to the top of the divide between the Red Creek and Currant Creek drainages.

The top of the formation in the Red Creek area is obscrued and nowhere exposed. The upper contact is presumed to be unconformable and may be slightly angular (up to $5^{o}$), (Figs. 2 and 3). The contact was drawn at the base of a steep slope that is characteristically formed by the overlying Uinta (?) Formation (Fig. 12).

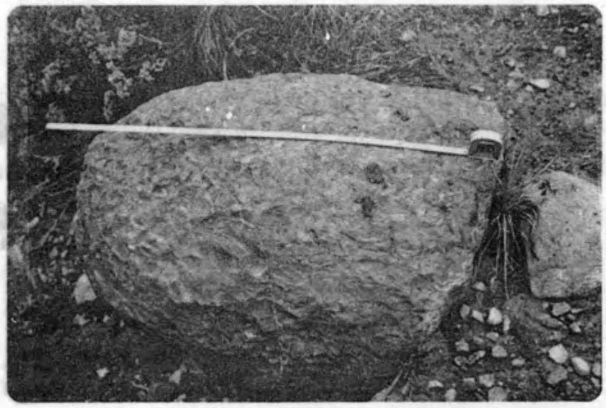


Figure 11. Photograph of oyster-bearing Cretaceous sandstone boulder in the Red Creek section.

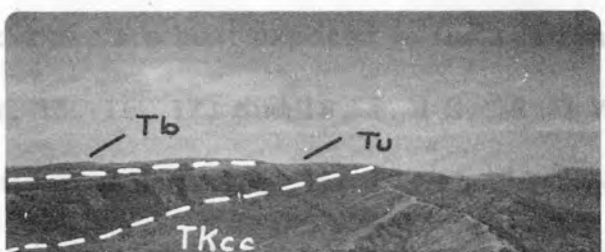



Figure 12. Photograph looking west across Red Creek showing steep Uinta slope and stratigraphy of area.

Divergence of dips is well expressed with dips along the base of the Currant Creek being about 48° south and ranging up section to about 10° or 12° south along the base of the Uinta (?) Formation. Local variation of dips may be more or less than 10° in a single outcrop.

The section measured is subject to some error because of the discontinuity of the outcrops and the numerous offsets required to complete the section. Figure 10 is a panoramic view of most of the section along the east side of Red Creek.

A generalized geologic section is shown on plate 1.

Duchesne River-Little Valley Area

Currant Creek rocks are best exposed in the eastern-most part of the study area in secs. 15, 16, 17, and 18, T. 1 S., R. 7 W. Scattered outcrops occur in portions of secs. 14, 15, 16, 17, 20, and 23, T. 1 S., R. 8 W. Huddle and McCann (1947) measured about 3,000 feet of Currant Creek west of the Duchesne River. The author measured 1,534 feet of Currant Creek east of the Duchesne River in sec. 18, T. 1 S., R. 7 W., in Little Valley (App. B). The Currant Creek thins rapidly eastward, due to an unconformity between the Currant Creek and overlying Uinta (?), and pinches out in the center of sec. 15, T. 1 S., R. 7 W.

Outcrops of Currant Creek in this area are interbedded lithic (petromict) pebble and granule conglomerates and subgraywacky to orthoquartzite type sandstones with some shale and siltstone. Detailed descriptions of the units that make up the formation in this area are presented as measured section number 2 (App. B). The conglomerates are mainly pebble and granule conglomerates composed of gray quartzite and black chert.

A sequence of boulder conglomerate and sandstone beds 337 feet thick is represented by units 1 to 13 (App. B). The conglomerate beds are light reddish-gray and contain frameworks of boulders, cobbles, and pebbles. The boulders and cobbles are composed mainly of Cretaceous Frontier Sandstone and contain marine fossils (Fig. 13). This sequence is traceable westward into the SE$\frac{1}{4}$ sec. 13, T. 1 S., R. 8 W., but then becomes obscured below alluvium. These same beds may correlate with the yellowish-brown sandstone and conglomerate beds exposed from units 35 to 58 that were described in the Red Creek area (figs. 10 and 13; and pl. 2).

Sandstones are light gray and are subgraywacke to orthoquartzite in composition. They contain angular to rounded grains; are fine- to coarse-grained; and are cemented with calcareous cement. Bituminous sandstone is present in the SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 16, T. 1 S., R. 7 W. These deposits are in the Uinta (?) and Currant Creek Formations in zones from 15 to 20 feet thick in the Uinta (?) and possibly 100 feet thick in the Currant Creek. The bitumen saturation appears to increase eastward.

The shale and siltstone units are red to reddish-brown or variegated, calcareous, and deeply weathered. Unit 22 (App. B) is a shale unit 20 feet thick that is covered with satin spar gypsum chips. This unit disappears eastward under alluvium but is exposed further eastward in SW$\frac{1}{4}$ sec. 16, T. 1 S., R. 7 W., where it has thickened to more than 100 feet.

Bentonite may be interbedded in the section and weathers to a "popcorn" surface.

Bedding ranges in individual units, from very thin- to massive-bedded and some of the sandstones exhibit low angle, small scale cross-bedding. Graded bedding is well developed in the sandstone and conglomerate units.

The base of the Currant Creek in this area was chosen on the basis of two criteria. The first is the change in slope between the more resistant Mesaverde and the less resistant Currant Creek. The second is based on the first appearance of graded bedding, up-section from the Mesaverde, in sandstones where resistance was not a determinable factor.

The top of the Currant Creek in this area was difficult to determine. Huddle, Mapel, and McCann (1951) chose the top of the Currant Creek at the base of a prominent conglomerate bed containing limestone cobbles and below an ostracodal limestone. The writer did not locate the fossiliferous limestone unit but chose the top of the Currant Creek at the base of the conglomerate bed in the eastern part of the area. This conglomerate unit is exposed in the Little Valley area and is a boulder, cobble, and pebble conglomerate about 20 to 30 feet thick that is traceable eastward to the end of Currant Creek exposures in the center of sec. 15, T. 1 S., R. 7 W. The conglomerate is composed of fragments of quartzite, chert, and limestone. The bed grades upward from boulders into coarse- and medium-grained sandstones. No alignment of framework fragments was observed.

In secs. 18 and 13 of T. 1 S., R. 7 and 8 W., the upper boundary of the Currant Creek has been moved down section from that proposed by Huddle, Mapel, and McCann (1951) to a position immediately above the youngest conglomerate containing Cretaceous sandstones. A look at the geologic map (pl. 1) will show why this move is justified. By protracting along the trace of the conglomerate bed that overlies the Currant Creek in eastern Little Valley it will be seen that the intersection of a protracted line with outcrops in western Little Valley will occur where the boundary is now drawn.

Divergence of dips is well defined here as in Currant and Red Creeks. Dips range from $44^{\circ}$ to $22^{\circ}$ south from the top of the Mesaverde to the base of the Uinta (?) Formation.

A generalized geologic section is shown on plate 1 and correlation of measured sections is shown on plate 2 (in pocket).

## Sedimentary Textures and Structures

### General Statement

Sedimentary textures discussed in this paper include size, sorting, and roundness of particles; boulder-cobble lineation and imbrication, percussion marks, and frosting of grains. Size, sorting, and roundness is discussed in sections one and two (App. A and B), and in the general description of the Currant Creek in this paper.

Both primary and secondary sedimentary structures are present in the Currant Creek Formation. Primary structures include bedding (planar-, cross-, and graded bedding), ripple marks, and rib-and-furrow structures. Secondary fractures include limonite concretions and manganese concretions and plates.

Boulder-Cobble Lineation and Imbrication

The best sedimentary texture for paleo-current direction studies in the Currant Creek are boulder-cobble lineation and imbrication. Throughout the mapped area, but more pronounced in the Currant and Red Creek areas, the framework of some conglomerate units is lineated and imbricated in a dominant direction (fig. 14). Many imbrications and lineations were measured on several outcrops with a Brunton compass and averaged. These averages are given, in places, in measured sections one and two (App. A and B). The framework particles are generally aligned northwest-southeast with imbrications of about 30° northwest. Orientations in the imbricated direction range from less than N. 20° W. to more than N. 70° E. The average orientation is about N. 64° W. These orientations indicate a general southeast flowing current with a source area somewhere to the northwest.

Figure 13. Photograph of conglomerate containing fossiliferous Cretaceous boulders and cobbles in the Duchesne River-Little Valley area.

Figure 14. Photograph of conglomerate columns of the basal Currant Creek in Red Creek area showing cobble alignment and imbrication. Arrow points northwest in direction of imbrication.

Percussion Marks

Large percussion marks are characteristic textures on the quartzites comprising the main framework of some conglomerate beds. Percussion marks up to three tenths of a foot in length were noted. Most of the percussion marks were elliptical in shape (fig. 15). These textures bear proof to the high velocities of the streams which transported and deposited the sediments of the Currant Creek.

Frosted Sand Grains

Many of the coarser quartz sand grains that compose the sandstones are frosted. These are reworked grains and may be weathered from the aeolian Navajo Sandstone of Jurassic Age.

Bedding

Bedding in the Currant Creek Formation includes planar-bedding, cross-bedding, and graded bedding. Planar-beds were classified after McKee and Weir (1953) as modified by Ingram (1954), and presented in Dunbar (1957, p. 97). Planar-bedding was from very thin- to massive-bedded. The classification of individual planar units is given in table 2.

The thickness of strata in some units of the Currant Creek is related to the grain size. The coarser the grains the thicker the unit and the finer the grains the thinner the unit.

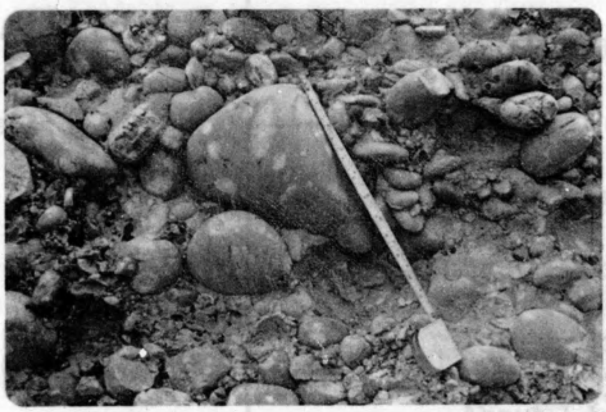


Figure 15. Photograph of cobble conglomerate in Red Creek area showing percussion marks on cobbles.

Table 2. Classification of bedding according to thickness. After McKee and Weir (1953) as modified by Ingram (1954), and after Dunbar (1957, p. 97).

| | |
|---|---|
| Beds | Massive-bedded |
| | About 5 feet |
| | Very Thick-bedded |
| | About 3 Feet |
| | Thick-bedded |
| | About 1 Foot |
| | Medium-bedded |
| | About 4 inches |
| | Thin-bedded |
| | About 1 Inch |
| | Very Thin-bedded |
| | About 2/5 Inch |
| Laminae | Laminated |
| | About 1/10 Inch |
| | Thinly Laminated |

Cross-bedding in the Currant Creek is the festoon or lenticular type and is poorly defined in most units. The cross-beds are of small scale, or fairly thin, and generally inclined at a low angle from less than $5^{\circ}$ to more than 30° between individual cross-beds. The cross-bedding generally strikes about northwest-southeast with inclinations to the southeast indicating current flow in that direction. Cross-beds, on the whole, were too poorly defined to measure accurate attitudes for paleo-current studies.

Graded bedding is well developed in many of the conglomerate and sandstone units (figs. 16 and 17). In the conglomerates the units grade toward the top of the formation from boulders or cobbles into pebbles, granules, or sand grains. In sandstones the units grade upward from coarse- to very fine-sand grains. In many places these units appear to be cyclic deposits. In other words, one graded bed is overlain by another and it, in turn, by another (fig. 16). These graded beds are probably the products of waning currents that produced grading of particles from cobbles into sand-sized particles upward in the unit.

Ripplemarks

Ripplemarks are very rare and were found in only one locality. Unit 64 of measured section 2 (App. B) contains ripplemarks along bedding planes in siltstone. The ripples are asymmetrical current features. Wave lengths range from two to seven inches but average two inches in length.

Rib-and-Furrow Structures

Rib-and-furrow structures are developed on bedding planes in siltstone

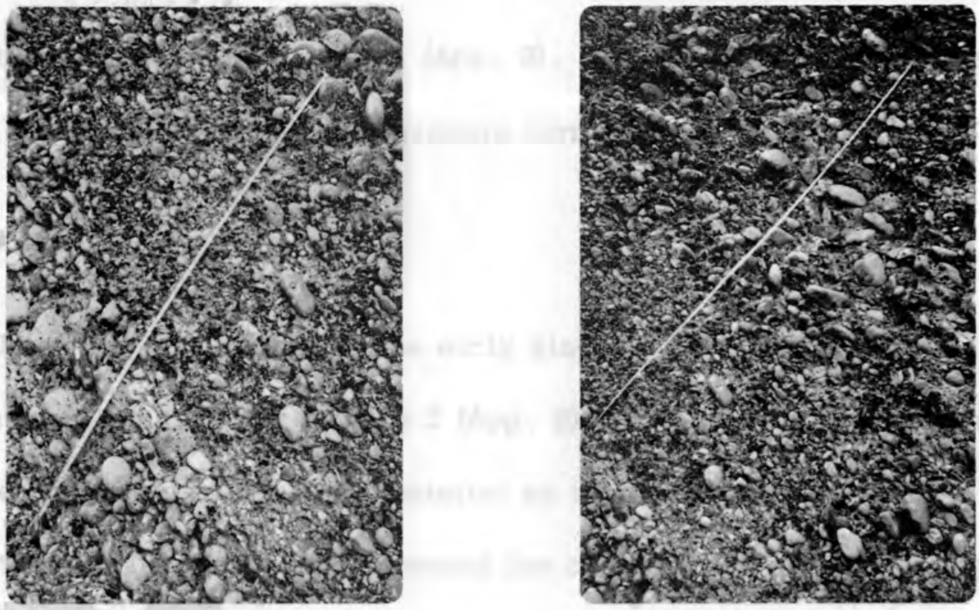


Figure 16. Photographs of graded-bedding in Red Creek area showing cyclic nature of the graded-beds. Beds grade upward from cobbles into pebbles into cobbles into pebbles from lower left to upper right of photographs.

Figure 17. Photograph of conglomerate in Red Creek area showing graded-bedding from bottom to top.

of unit 64 of measured section 2 (App. B). These structures indicate diversified current directions. The average current direction noted was S. 81° E.

Concretions

Limonite concretions in the early stage of development were found in one outcrop in unit 41 of section 2 (App. B). They are forming in sandstone and are composed of the same material as the host rock. Haloes of dark limonite up to 0.1 inch wide surround the concretions. These concretions are very soft and friable as is the host rock that contains them.

Manganese concretions and plates were noted in one locality in unit 69 of section 2 (App. B) on the surface of a small slope exposure.

## Reworked Fossils

Fossils of Cretaceous age were found in, and weathering from, boulders and cobbles in units 1, 3, 8, 11, and 13 of measured section 2 (fig. 13 and App. B). These fossils were identified by the author as being derived from the Frontier Sandstone of Upper Cretaceous age. The faunal assemblage collected is as follows:

Cephalopods:

*Baculites codyensis*

Pelecypods:

Camptonectes stygius

Cardium pauperculum

Exogyra columbella ?

Exogyra suborbiculata

Exogyra sp.

Gervillia propleura ?

Inoceramus dimidius ?

Inoceramus fragilis ?

Inoceramus labiatus

Inoceramus undabundus ?

Liopistha (Psilomya) concentrica ?

Mactra emmonsi

Mactra siouxensis ?

Mactra sp.

Ostrea malachitensis

Ostrea (Gryphaea ?) patina

Ostrea soleniscus

Ostrea sp.

Trigonarca obliqua

Gastropods:

Campeloma vetula?

Campeloma? sp.

Fusus (Neptunea?) venenatus

Gyrodes depressa

Gastropod (unnamed?)

Vertebrates:

Sharks' teeth

The fossils listed above were identifed by the author following the original work of Meek and Hayden (1876) and Stanton (1893).

Provenance and Origin

A possible source area for the sediments that make up the Currant Creek Formation was proposed by Walton (1944, p. 120), where he states "The lithologic characteristics of the Currant Creek formation indicate that it was deposited at or near the mouths of streams and rivers flowing out of the mountains to the west." Walton (1964, p. 142) further refers to such a possible source as the Strawberry Valley Thrust sheets, rather than orogenic uplift of the Uinta Mountains because of similar dips on either side of the Mesaverde-Currant Creek boundary. Murany (1964, p. 149) placed a possible similar source area for the Currant Creek and Wasatch Formations to the northwest toward the central Wasatch Mountains, based on thickening of isopach contours drawn across the Wasatch-North Horn-Tuscher Formation interval.

Current-oriented cobbles and boulders, cross-beds, and rib-and-furrow structures in the Currant Creek all trend northwest indicating definite southeast flowing currents. Close examination of the Geologic Map of Utah, Northeast Quarter (Stokes and Madsen, 1961), shows very little Weber Quartzite, of which most of the boulder, cobble, and pebble material of the Currant Creek is composed, exposed in the vicinity of the Strawberry Valley Thrust sheet. Also, no Precambrian Mutual Quartzite is exposed in the thrust area but Mutual is a common framework material in the Currant Creek.

In the Heber area, a volcanic field, mapped as $T_1$ap (Early Tertiary (?) andesitic pyrocastic rocks) on the state geologic map, trends northwest and is about six miles wide and 30 miles long. This field may follow an older stream channel or channels that may have provided fluid transport for the sediments of the Currant Creek. Also, Weber Quartzite is exposed both on the Wasatch and Uinta Mountains, along with some Precambrian Mutual, in this vicinity.

Therefore, the junction of the Uinta and the Wasatch Mountains seems most logical as a source area for the Currant Creek sediments. This also agrees with the northwesterly thickening of the Wasatch-North Horn-Tuscher isopach as mapped by Murany and the northwesterly current aligned boulders and cobbles noted within the Currant Creek Formation.

## Sediment Transport and Environment

Walton (1944, p. 120) recognized that the Currant Creek was deposited from the west. The Currant Creek sediments were probably deposited from a fluvial environment. This is attested to by the rounding of boulders, cobbles, and pebbles; percussion marks on framework particles, waning current graded bedding, and the small scale, low angle cross-bedding produced by stream deposition.

Streams or rivers providing transport must have been flowing at very high velocities. Large percussion marks as large as one inch by three inches in size are common primary structures on framework particles. Also, the absence of limestones in the conglomerates of the Currant Creek attests to the tremendous grinding that may have taken place within the streams. The limestone may have been reduced to fine powder allowing stream water to dissolve the powder. Only the siliceous cherts survived the stream abuse to be subsequently deposited with the Currant Creek sediments. Cyclic graded bedding suggests successive periods of slow and rapid transport of sediments corresponding with successive periods of tectonic activity and stability in the source area. These events of unrest and stability may also account for some of the diversity of dips in the Currant Creek deposits.

The Currant Creek Formation was probably deposited near the headwaters and along the floodplains of streams or rivers flowing down the now buried stream channels from the Wasatch-Uinta Mountains junction area.

Fairly good sorting, particle rounding, boulder-cobble alignment and imbrication, and lenticular channel sandstones suggest a floodplain environment of deposition. The general decrease in grain size eastward suggests a loss of energy in the transportation medium where stream competencies were reduced and the streams were carrying only sand- silt- and clay-sized particles.

The composition of the conglomerates (mostly Weber Quartzite, black chert, and Mutual Quartzite) points to a source area composed predominantly of these rocks. The predominant gray to light gray color of the Currant Creek sediments is derived mainly from the gray Weber Quartzite. Red coloration does not appear in the section until the source area was uplifted and weathered deeply enough to expose Precambrian rocks rich in ferric iron. These Precambrian rocks probably provided reddish color for the overlying Uinta (?) Formation.

## Age and Correlation

### General Statement

The age and correlation of the Currant Creek Formation has been the subject of controversy with many workers in the past. In order to present any valid conclusions a discussion of previous ideas by other geologists, field evidence, and subsurface correlations is warranted.

Summary of Previous Correlations

To this date no one person has studied all aspects of the Currant Creek Formation but some aspects of it have been incorporated in reports covering larger areas. These include the reports of Lupton (1912), Walton (1944), Huddle and McCann (1947), Williams (1950), Huddle, Mapel, and McCann (1951), Bissell (1952), Stokes and others (1955), Walton (1957), Abbot (1957), Murany (1963), Walton (1964), Murany (1964), and Hale and Van De Graaff (1964). Moussa (1966) studied the Price River Formation in the Wasatch Plateau and his studies are also reviewed.

Lupton (1912, p. 607-608) incorporated the Currant Creek and a large part of the Uinta (?) Formation into the Wasatch Formation in his geologic mapping of the Tabby Mountain coal field. Lupton estimated the Wasatch to be about 10,000 feet thick in the Tabby Mountain area. He placed the entire section within the Tertiary Period.

Walton (1944, p. 117-120) named the Currant Creek Formation and differentiated it from the overlying Uinta (?) Formation by its color change (the Uinta (?) being more red than the Currant Creek) and its lithologic character. He suggested a possible Late Cretaceous to Early Eocene age and roughly correlates the formation by lithologic characteristics, stratigraphic position, and other general relationships with the Price River and North Horn Formations of the Wasatch Plateau.

Huddle and McCann (1947) placed the Currant Creek in time as questionably Late Cretaceous on their columnar sections. They correlated the Currant Creek with the Price River Formation in the Wasatch Plateau.

Williams (1950, p. 103-104) defined the Wasatch Group as comprising the North Horn, Flagstaff, Colton, Currant Creek, Tuscher, and Wasatch Formations and thus proposed a Late Cretaceous to Eocene age for the Currant Creek Formation.

Bissell (1952, p. 613-614) discussed the Currant Creek as a part of the northeast Strawberry Valley Quadrangle and concurred with Walton (1944) in the tentative age assignment of Price River-North Horn equivalent for the Currant Creek, thus indicating a Late Cretaceous-Paleocene age.

Stokes and others (1955, p. 2014), in discussing the Cretaceous-Tertiary boundary problem in the northwestern Uinta Basin, discussed the correlations of Walton (1944), and Bissell (1952). They correlate the Currant Creek with the Price River, North Horn, and Wasatch Formations (1955, p. 2006-2007) in accordance with Walton.

Abbot (1957, p. 103) tentatively correlated the Currant Creek with the Price River, North Horn, and Wasatch Formations in the Western Uinta Basin. This placed an Upper Cretaceous-Eocene age on the formation. He believed that the Currant Creek was gradational with the overlying Uinta (?) making the uppermost Currant Creek Eocene.

Walton (1957, p. 100) correlated the Currant Creek to the "congomeratevariegated shale facies of the North Horn and Price River formations where they are exposed in the "Narrows" of Spanish Fork canyon at the north end of the Wasatch Plateau."

Murany (1963, p. 80), in correlating the Wasatch Formation, favors the idea that the "Price River conglomerates and Currant Creek conglomerates are equivalent in age and represent a coarse western facies of the North Horn-Wasatch formation."

Murany (1964, p. 149-150) correlated the Wasatch Formation as he did in 1963. Isopach mapping of the Wasatch-North Horn-Tuscher Formations by Murany indicated a general thickening of the Wasatch toward the Currant Creek area and central Wasatch Mountains indicating a possible source area for the Wasatch. According to Murany (1964, p. 149), "The stratigraphic position of the Currant Creek Formation therefore, may correspond to the Wasatch and Green River Formation, with the lower conglomerate section of the Currant Creek being a coarse facies of the Wasatch Formation." This would indicate a Paleocene-Eocene age for the Currant Creek.

Walton (1964, p. 139-143) correlates the Currant Creek with the Price River and North Horn of the northern Wasatch Plateau, and correlates the lower Currant Creek roughly with the Echo Canyon Conglomerate on the northwest flank of the Uinta Mountains. Williams and Madsen (1959, p. 122-125) indicated a Late Cretaceous age for the Echo Canyon.

Hale and Van De Graaff (1964, p. 118-119), in a correlation diagram of Cretaceous formations in adjoining areas of Utah, Wyoming, and Colorado, have correlated the Currant Creek, in part, with the Cretaceous Echo Canyon, Price River, and Tuscher Formations; and the Tertiary Wasatch and Knight Formations (fig. 18).

Moussa (1966, p. 35), in his doctoral thesis, proposed the name Bennion Creek Formation for the conglomerates that comprised the Price River Formation in Spanish Fork Canyon and Bennion Creek in the northern Wasatch Plateau. He placed the Bennion Creek unconformably below the Flagstaff Limestone, transecting beds of the North Horn and overlying unconformably the remainder of the formations of the Price River Group (fig. 18). The age of the Bennion Creek was considered as Late Cretaceous and possibly Early Paleocene. Further discussion of the Bennion Creek will appear in a later section of this report.

## Field Evidence

Field evidence which may have a bearing on the assignment of a tentative age and correlation to the Currant Creek includes unconformities, basal conglomerates, stratigraphic position, similarity to the Wasatch and North Horn Formations, and the presence of "frameworks" of Cretaceous Frontier Sandstone boulders and cobbles in some of the conglomerates of the Currant Creek.

The Currant Creek overlies the Cretaceous Mesaverde Formation unconformably with no apparent discordance of dip, except in the Currant Creek area, and underlies the Uinta (?) Formation with a slight angular unconformity in the Red Creek and Duchesne River-Little Valley areas. This indicates that it is younger than Mesaverde (Late Cretaceous) and older than Uinta (?) (Eocene).

The presence of predominant conglomerates in the lower part of the Currant Creek in the western and central parts of the mapped area indicate a definite change in lithology from sandstone to conglomerate and some tectonic activity in the source area. Folding of the Mesaverde and truncation of the folds followed by deposition of Currant Creek sediments in the Currant Creek area points to a later age than Mesaverde for the formation. However, in the Duchesne River and Little Valley areas the beds are transitional from Mesaverde to Currant Creek and lithologically can be differentiated only by resistance to erosion and by graded- versus planar-bedding.

The stratigraphic position of the Currant Creek strongly favors a Late Cretaceous-Early Eocene age assignment. The Currant Creek unconformably overlies the Mesaverde in the study area. In the Wasatch Plateau the Mesaverde Group is overlain by the Bennion Creek, which, in turn, is overlain by the Flagstaff Formation with the Bennion Creek being partially equivalent to the North Horn Formation. Spieker (1946, p. 134-135) places the Cretaceous-Tertiary time boundary somewhere in the North Horn Formation (fig. 18). The Currant Creek is overlain unconformably by the Uinta (?) Formation which gradationally overlies the Green River Formation of Eocene age in the western, central, and eastern Uinta Basin (fig. 15). The Green River Formation gradationally overlies the Wasatch Formation of Late Paleocene-Eocene age in the eastern, and central Uinta Basin and overlies the Colton Tongue of the Wasatch in the western Uinta Basin (fig. 18).

Lithologically, sediments comprising the Wasatch and the North Horn Formations are very much the same as the Currant Creek Formation except for the presence of fresh water limestones in the Wasatch and North Horn. Fluvial sediments of the Wasatch are "red and green silty shale, lenticular beds of massive, cross-bedded sandstone, and occassional thin lenses of fine-grained, gray, dense limestone. There are also conglomerates that have a local distribution which form only a small percent of the formation" (Murany, 1963, p. 66). Goodwin (1961, p. 56) presents a threefold zonation of the Tertiary rocks in the subsurface. Of these, "Rocks assigned to the Wasatch formation contain interbedded conglomeratic sandstones in which the pebbles are less than 50 percent limestone. Pebbles of Mesozoic and Permian lithologies are dominant." This description of Wasatch conglomerates fits, in a general way, that of the Currant Creek conglomerates because the Currant Creek conglomerates are composed principally of Weber Quartzite and black Paleozoic chert. Fluvial sediments of the North Horn contain variegated shale and sandstone, conglomerate, and some fresh water limestone (Spieker, 1946, p. 133). The Currant Creek has previously been described in this paper and is composed of fluvial sediments also.

The sequence of conglomerate and sandstone beds containing yellowish-brown, Cretaceous cobbles and boulders with fossils that were described in the Little Valley and Red Creek areas indicate that at that time of deposition the sediments were post-Frontier and post-Mesaverde in age and probably are Late Cretaceous to Early Paleocene in age. On this basis then, the Cretaceous-Tertiary boundary may be placed somewhere between the base of the Currant Creek and the base of the first conglomerate containing Cretaceous particles. A rough correlation may be drawn with the Cretaceous-Tertiary boundary of Spieker (1946, p. 135), for the North Horn Formation in the Wasatch Plateau. This, then, is considered as evidence for correlation of the lower part of the Currant Creek with the North Horn Formation.

Subsurface Evidence From Well Data

In attempting to correlate the upper part of the Currant Creek Formation with the Wasatch Formation, several subsurface lithologic and electric logs were examined. Because there is but one well in the area that penetrated the Currant Creek (pl. 2), only very rough correlations could be made. This well is the Sinclair Oil Company Bert L. Coleman No. 1 in the NE$\frac{1}{4}$ sec. 13, T. 2 S., R. 10 W. However, the electric logs that have been made of the Currant Creek from the Sinclair well have similar curves to those logs made of the Wasatch from other wells. These logs have fairly low resistivities and fairly straight, and slightly inclined, toward the positive side of the log, spontaneous potential "shale lines." Penetration of wells into the Wasatch is very shallow and south of the study area the deepest penetration into the Wasatch is only about 250 feet. The tops of the Currant Creek and Wasatch Formations are picked on the electric logs by a decrease in resistivity from more than 50 to less than 20 ohms or an average decrease over five wells of about 26 ohms.

A subsurface structure contour map, drawn on the tops of the Wasatch and the Currant Creek, was prepared in an attempt to correlate the top of the Currant Creek with the top of the Wasatch. Instead of the hoped for correlation, a large displacement of approximately 1,000 feet or more was discovered by closely spaced contours and named, by the writer, the Uinta Basin Fault (fig. 19).

Cretaceous-Tertiary Time Boundary

The problem of the Cretaceous-Tertiary time boundary in Utah has been well summarized by Stokes, and others (1955, p. 2012-2016).

In the Wasatch Plateau Spieker (1946, p. 135) places the Cretaceous-Tertiary boundary in the North Horn Formation somewhere between the last occurrence of dinosaur remains and the first occurrence of placental mammals.

The basal conglomerates in the Currant Creek in the western and central parts of the mapped area are evidence of a major change in sedimentation from the upper transitional Mesaverde beds to the continental fluvial beds of the Currant Creek. However, in the eastern part of the mapped area, the time boundary is drawn between the first graded bedding occurrence at the base of the formation, and the first occurrence, up-section, of conglomerates with a framework of Cretaceous sandstone, boulders, and cobbles. In this area the base of the formation is gradational and represents transitional beds. The same reasoning may apply to the Red Creek area where similar conglomerates are exposed. Therefore the Cretaceous-Tertiary time boundary is drawn throughout the area above the Mesaverde-Currant Creek contact.

## Conclusions

After a review of the correlations and age assignments of the Currant Creek by various authors and after presenting field and subsurface evaluations the Currant Creek is correlated in agreement with Walton (1944 and 1964), Abbot (1957), and Murany (1963 and 1964), and the age of the

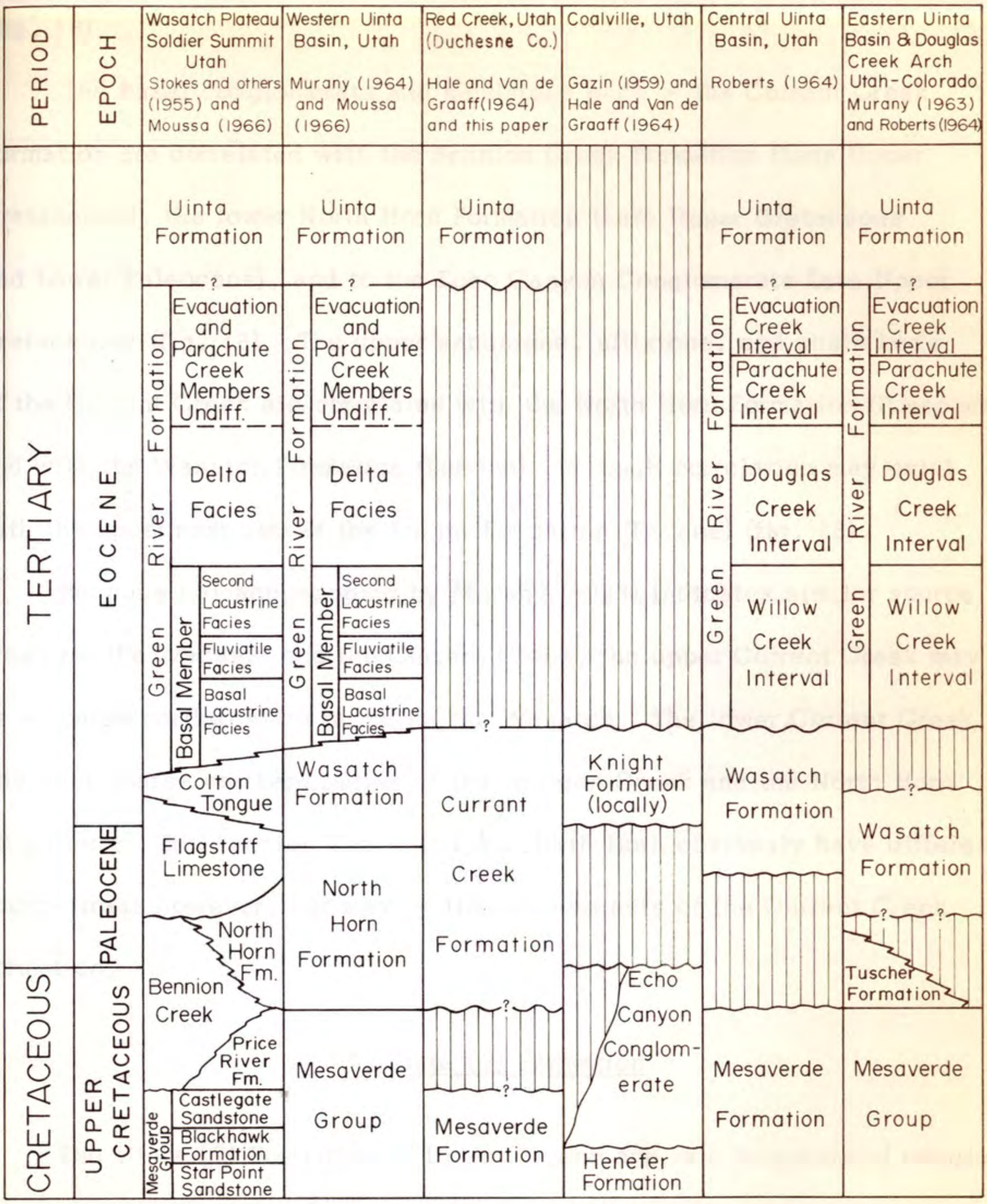



Figure 18. Correlation of Cretaceous and Tertiary Formations in the Uinta Basin of Utah and Colorado.

Currant Creek is suggested as Late Upper Cretaceous to Early Eocene (fig. 18).

The basal conglomerate and sandstone beds of the Currant Creek Formation are correlated with the Bennion Creek Formation (Late Upper Cretaceous), the lower North Horn Formation (Late Upper Cretaceous and Lower Paleocene), and to the Echo Canyon Conglomerate Late Upper Cretaceous) (fig. 18). The upper sandstone, siltstone, and shale beds of the Currant Creek are correlated with the North Horn Formation (Paleocene), and with the Wasatch Formation (Eocene). A rough correlation may exist with the uppermost part of the Knight Formation (Eocene) (fig. 18).

Because isopach mapping by Murany (1963) indicates similar source areas for the Wasatch and the Currant Creek, the upper Currant Creek may be a coarse northwestern facies of the Wasatch. The lower Currant Creek may be a coarse northern facies of the Bennion Creek and the North Horn Formations. The Bennion Creek and the North Horn obviously have different source areas however, but may be time equivalents of the Currant Creek Formation.

## Uinta (?) Formation

The Uinta (?) Formation of Upper Eocene age is a sequence of conglomerate, sandstone, siltstone, and shale. These rocks have not been positively identified as belonging to the Uinta Formation by previous authors and are questionably referred to the Uinta. The Uinta (?) throughout the mapped area forms a steep slope in its lower part. Bissell (1952, p. 616) measured about 4,500 feet of Uinta (?) in the northeast Strawberry Valley Quadrangle and Walton (1944, p. 122) measured 5,400 feet of Uinta (?) along the Duchesne River.

The formation is predominantly a conglomerate interbedded with sandstone in the Currant Creek area. The conglomerate is red to reddish-brown in color with a framework of cobbles, pebbles, and granules derived from rocks of many geologic periods forming a lithic (petromict) conglomerate. Red Ledge, in Red Ledge Hollow, is a good exposure of the Uinta (?) in the Currant Creek area (fig. 8). In the Red Creek area the Uinta (?) is a series of sandstones and siltstones; is light gray to reddish-brown in color and orthoquartzitic in composition. In Red Creek, as in Currant Creek, the formation is more resistant than the underlying Currant Creek and forms steep slopes (figs. 2 and 3). In the Duchesne River-Little Valley areas the Uinta (?) is a series of conglomerate, sandstone, siltstone, mudstone, and shale beds ranging from light gray to grayish-green and red in color.

The Uinta (?) Formation overlies the Currant Creek Formation with a slight angular unconformity of about $5^{\circ}$ in the Red Creek area but overlies the Currant Creek disconformably in other areas (figs. 2 and 3).

The contact with the Currant Creek is taken at the base of a steep reddish slope that forms the lower Uinta (?) Formation. Low dips of from less than $5^{\circ}$ to more than $20^{\circ}$ south are common on lower Uinta (?) outcrops.

Bishop Conglomerate

The Bishop Conglomerate of Miocene (?) age is a generally unconsolidated boulder-cobble conglomerate. It is red to grayish-white in color and contains a framework of many other rock formations. The boulders and cobbles are generally rounded and some are coated with caliche. The Bishop covers the tops of many of the higher mountains in the mapped area and supplies talus gravels to the lower slopes (figs. 2 and 3). The boulders and cobbles of the Bishop are readily distinguished from those of the Currant Creek by the high percentage of limestone fragments in the Bishop. The Bishop Conglomerate overlies other formations unconformably in all areas and lies on the Lake Mountain erosional pediment surface (fig. 2 and 3).

# STRUCTURE

## Regional Structure

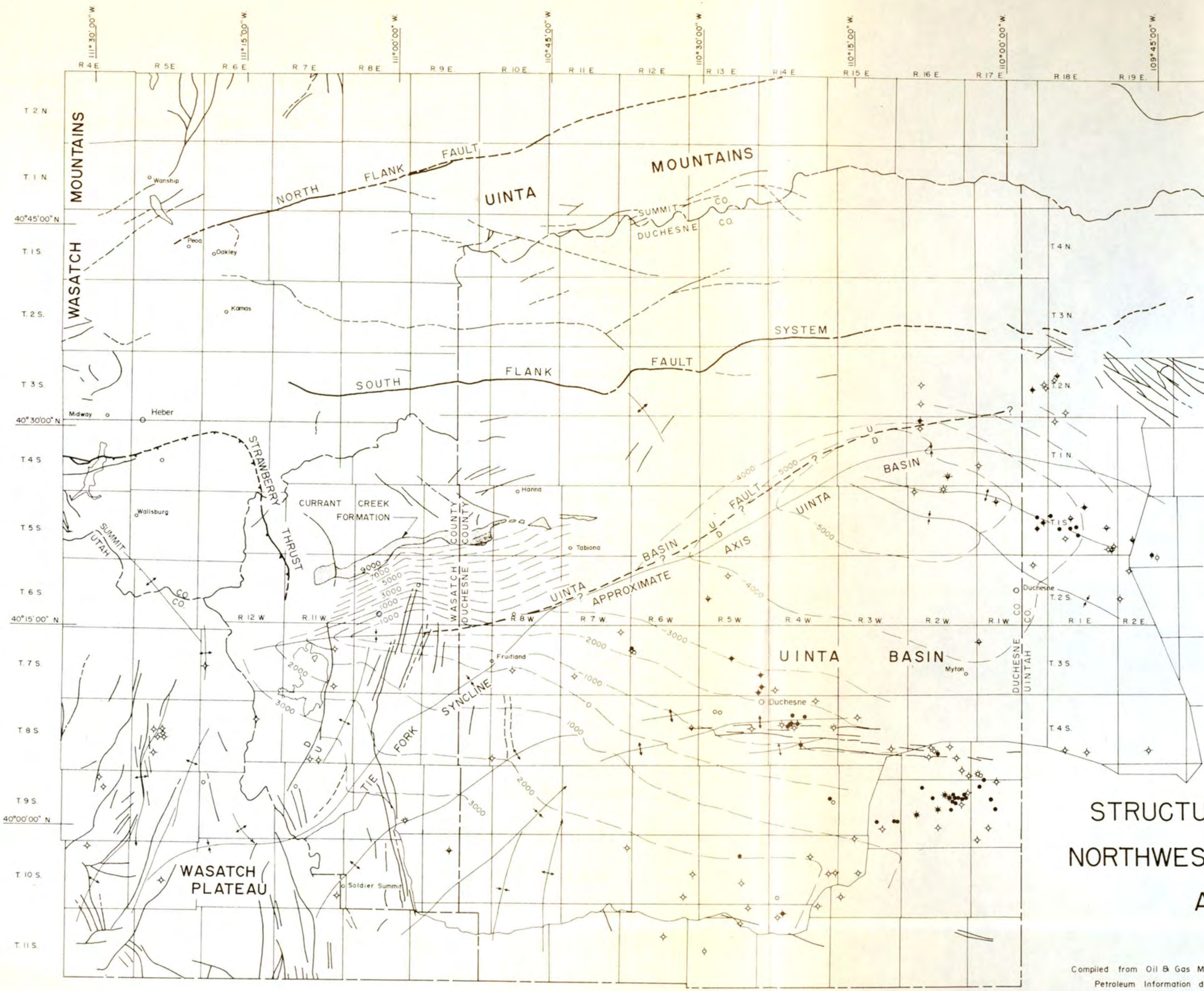
The Uinta Basin is a broad structural depression with a long axis parallel with the Uinta Mountains. The basin is the northernmost part of the Colorado Plateau Province. It is bordered on the north by the Uinta Mountains, on the east by the Park Range in Colorado, on the south by the Book Cliffs, and on the west by the Wasatch Plateau and the Wasatch Mountains (Fenneman, 1931, p. 277, 304-305).

The Uinta Mountains to the north have greatly influenced the structural relationships found along the northern Uinta Basin. The structure of the Uinta Mountains has been described by Emmons (1907), Weeks (1907), Schultz (1918), and Forrester (1937).

The area of outcrops of Currant Creek Formation is in the northwestern Uinta Basin and on the southwestern flank of the Uinta Mountains. Major regional structural elements are shown in figure 19.

## Local Structure

Structural elements recognized along the outcrops of the Currant Creek Formation consist of folds, faults, and fractures. The outcrop area studied is on the northwest limb of the Uinta Basin with the beds dipping southward from more than $50^{\circ}$ to less than $10^{\circ}$ toward the basin. The



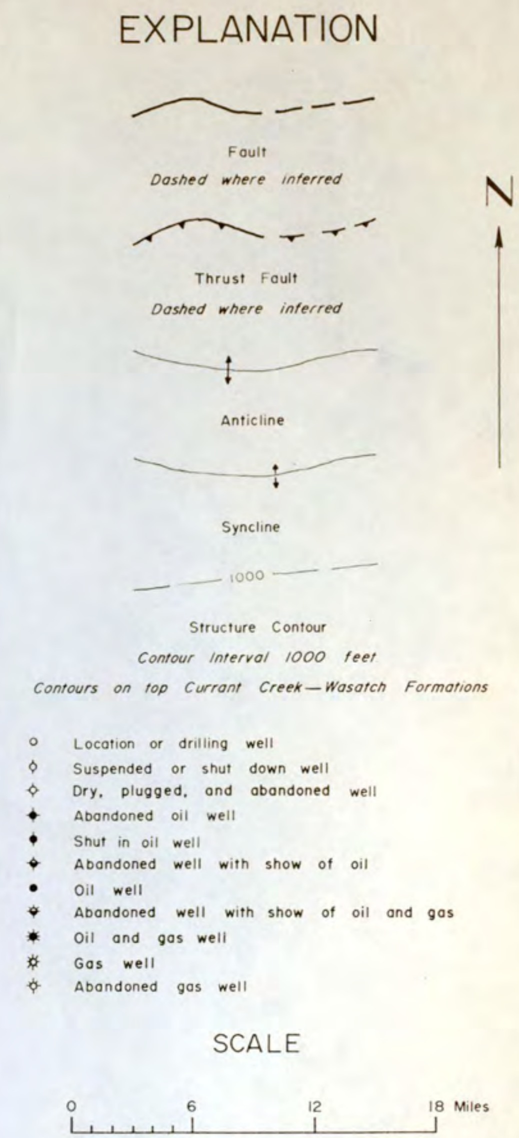




Figure 19.

# STRUCTURAL MAP OF THE NORTHWESTERN UINTA BASIN AND VICINITY

BY R. F. GARVIN, 1967

Compiled from Oil & Gas Map of Eastern Utah (1966), Geologic Map of Utah (1961), and Petroleum Information data.

attitude of bedding becomes less steeply inclined southward from the area and is almost horizontal near U. S. Highway 40.

## Folds

Folding in the area of Currant Creek outcrops lies partially within the eastern belt of folding in the northeast Strawberry Valley Quadrangle described and mapped by Bissell (1952, fig. 2). According to Bissell (1952, p. 621), "The folds have formed where the prevailing east-west striking strata of the south flank of the Uinta Mountains abruptly swing to a northwest-southeast, and then a north-south strike." The fold associated with this structure is a syncline plunging northeast. The syncline is located in secs. 31 and 32, T. 1 S., R. 10 W., and in secs. 1 and 6, T. 2 S., R. 10 and 11 W. in Racetrack Creek and Currant Creek (pl. 1).

Three anticlinal structures were mapped by the writer (pl. 1). A small anticlinal nose plunging northwest was mapped near the town of Hanna in secs. 16 and 17, T. 1 S., R. 8 W., but is given no further significance. An anticlinal nose plunging northwest may be present in the vicinity of secs. 17, 18, 19, and 20, T. 1 S., R. 8 W., where topographic expression and geologic mapping suggest a slight bending of strata (pl. 1). A small anticlinal nose or dome is indicated by radial drainage in sec. 20, T. 1 S., R. 9 W.

## Faults

Some faulting was observed by surface outcrop studies and inferred from subsurface studies of the Currant Creek Formation. These faults are divided into two categories: minor faulting and the Uinta Basin Fault.

### Minor Faulting

Bissell (1952, p. 624) recognized a high angle normal fault striking a few degrees west of north in the southeast and northwest quarters of the northeast Strawberry Quardrangle. The fault is mapped, in part, in secs. 1 and 2, T. 2 S., R. 11 W. The area of fault exposure is covered with dense vegetation and no outcrops are visible. This fault was mapped primarily on the basis of a northward offset in the Currant Creek outcrop pattern. The fault has downdropped Uinta (?) Formation on the west against Jurassic strata on the east and truncates part of the syncline described above. The age of faulting is tentatively placed, by the author, within the Eocene-Oligocene (?) time interval because northward in the Strawberry Quadrangle the fault is overlain by Oligocene (?) volcanics and in the mapped area displaces Eocene strata (interpreted from Bissell, 1952, fig. 2).

A smaller fault with a displacement of about five feet and an attitude of N. 16° W., 82° SW., was observed at the head of a narrow gorge in the NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 33, T. 1 S., R. 10 W., in Bear Hole Hollow. The sides of this minor fault are slickensided and coated with limonite and manganese stains.

Uinta Basin Fault

In preparing a structure contour map on the top of the Wasatch and Currant Creek Formations a vertical displacement of 1,000 feet or more was apparent from closely spaced controus (fig. 19). This displacement is interpreted to be a fault that follows the approximate axis of the Uinta Basin striking about N. 80° E. The name Uinta Basin Fault is herewith proposed for this displacement. Subsurface data for structure contours on the Wasatch Formation were obtained from oil well data cards published by Petroleum Information Corporation. Subsurface data for drawing structure contours on the Currant Creek were derived by extending elevations down dip from surface outcrops using surface dips and data from one well. The structure contours and the fault are superimposed on the regional structure map (fig. 19).

Ritzma (1967, personal communication) suggests that the Uinta Basin Fault may be a thrust fault. The Uinta Basin Fault is extended on the map (fig. 19) northeastward through the Starr Flatt Oil Field, in T. 1 and 2 N., R. 2 W., Uinta Special Meridian, Duchesne County, where a fault of similar strike, but of less magnitude (less than 200 to more than 500 feet of displacement), has been mapped by Goodwin (1961, p. 56). The area of greatest displacement on the fault may occur along the southwestern extension of the fault in tps. 2 and 3 S., Rs. 8 and 9 W. Westward the fault may lose its definition and die out (fig. 19).

More is mentioned about the Uinta Basin Fault in the Age and Correlation and Economic Geology sections of this report.

## Fractures

Near-vertical fracturing perpendicular to the strike of bedding was noted throughout the Currant Creek Formation. Conjugate fracturing is predominant in the lower conglomerate and sandstone beds but is absent in the sandstone units of the uppermost Currant Creek, possibly because the lower Currant Creek is less friable than the upper Currant Creek. Limonite staining of fractures is a common characteristic.

The best development of fractures is exposed in a narrow gorge in the NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 33, T. 1 S., R. 10 W., where the gorge itself follows a near-vertical fracture. These fractures were not of a mappable scale, however, (1:24,000).

# TECTONIC HISTORY

## General Statement

Detailed accounts of the structural history of the Uinta Mountains and the Uinta Basin have been published by Forrester (1937, p. 648-664), Walton (1944, p. 125-128), Bissell (1952, p. 625-633 and 1959, p. 163-165), Crowley (1957, p. 25-29), and Osmond (1964, p. 47-58).

Locally, Walton's account of tectonic history is the most applicable to the subject of this report. Disturbances discussed by Walton and recapitulated here that have a direct bearing on the tectonic structures within the Currant Creek Formation are: the Tabby Mountain disturbance and the folding of the Uinta Mountain anticline. Also discussed are the first uplift of the Uinta Mountains, second uplift of the Uinta Mountains, regional uplifts, subsidence of the Uinta Mountains, epeirogenic uplift, and recent activity.

## Tabby Mountain Disturbance

The Tabby Mountain disturbance (Late Cretaceous to Early Paleocene time) is reflected by the disconformity between the Mesaverde and Currant Creek beds. According to Walton (1944, p. 125), formation of the Uinta Basin began with major diastrophism and the uplift and erosion of Cretaceous rocks in the vicinity of Tabby Mountain. Some uplift may have occurred in the Heber area. This event may be represented by the basal conglomerate units of the Currant Creek. Walton (1944, p. 126) states that "This orogeny represents the initial phase of the Laramide Revolution in this area." The Bennion Creek Formation in the northern Wasatch Plateau may have been deposited during this same diastrophic event.

## Folding of the Uinta Mountain Anticline

Deposition of the Currant Creek Formation during Early Paleocene time may represent the first uplift of the western Uinta Mountains into a broad arch. The presence of predominant frameworks of Pennsylvanian Weber Quartzite and Paleozoic black chert in the conglomerate units of the lower Currant Creek suggests a source area of considerable relief. Surface rocks extending across the Uinta Arch were probably Upper Paleozoic through Mesozoic rocks. Erosion of the arch supplied sands from Mesozoic rocks and gravels from the upper Paleozoic rocks to the source streams that flowed southeastward from the Heber area. High velocity stream flow probably reduced the limestone leaving black chert residues and water high in $CaCO_3$ content. The more resistant Weber Quartzite fragments were rounded by stream transport to the shapes found in outcrops today. High percentages of $CaCO_3$ in the streams provided cementing material for the newly deposited sediments.

Divergence of dips within the Currant Creek suggest successive periods of uplift and quescence in the source area.

The South Flank Fault System of the Uintas may have originated during the time of early movement of the Uinta Mountains. The Uinta Basin Fault may have originated during the same period. The Uinta Basin Fault is older than the Uinta Formation but displaces rocks of Wasatch age and therefore may be Early to Middle Eocene in age.

Walton (1944, p. 126) states that, "the first diastrophism involving the whole Uinta Basin was probably contemporaneous with deposition of the Currant Creek formation." Widespread peneplanation of the Uinta Mountains occurred during Late Paleocene to Early Eocene time and formed the Gilbert Peak pediment surface, following deposition of the upper Currant Creek sandstones, siltstones, and shales and the Wasatch Formation.

A long period of erosion of the Currant Creek followed after deposition during Green River Lake time. Some phases of the Green River Lake may have extended very near to the floodplain deposits of the Currant Creek but subsequent erosion has removed any Green River sediments that may have been deposited in the vicinity of the Currant Creek Formation.

## First Uplift of the Uinta Mountains

Following the Green River deposition, of Middle to Late Eocene time, the first uplift of the Uinta Mountains occurred, supplying sediment to the Uinta (?) Formation of Late Eocene age. The lower conglomerates of the Uinta (?) were derived from the Uinta Mountains and contain a diversified framework of rocks from many geologic periods (after Crowley, 1957, p. 28 and Walton, 1944, p. 127).

## Second Uplift of the Uinta Mountains

Uplift of the Uinta Mountains followed deposition of the Uinta Formation, and tilted the newly deposited rocks. Widespread peneplanation followed with subsequent deposition of the Duchesne River Formation of Late Eocene age. Widespread peneplanation commenced during and after Duchesne River deposition forming the Bear Mountain and Lake Mountain terraces (after Crowley, 1957, p. 29, and Walton, 1944, p. 127).

## Regional Uplifts

Regional uplifts during the Middle and Late Tertiary, such as the San Rafael Swell to the south and the Uncompahgre Plateau to the east, followed deposition of the Duchesne River. Uplifts in the Uinta Mountains resulted in the deposition of the Bishop Conglomerate of Miocene age over the peneplaned surfaces formed during upper Eocene and Oligocene time. All of these uplifts may have influenced the present structure of the Currant Creek, Wasatch, and Green River Formations. It was also at this time that the present axis of the Uinta Basin may have formed (after Walton, 1944, p. 127 and Crowley, 1957, p. 29).

### Subsidence of the Uinta Mountains

Subsidence of the east end of the Uinta Mountains followed the deposition of the Bishop Conglomerate. This subsidence is believed to have caused tension cracks, filled with gilsonite, in the Uinta Basin and regional downwarping of the Lake Mountain surface (Crowley, 1957, p. 29, and Walton, 1944, p. 127-128).

### Epeirogenic Uplift

Epeirogenic uplift of the entire Rocky Mountain region occurred in Late Tertiary or Early Quaternary time. Forrester (1937, p. 631-666), has estimated an uplift of from 8,000 to 10,000 feet for the Uinta Mountains area (Walton, 1944, p. 128).

### Recent Activity

Since the time of epeirogenic uplift there has been little or no tectonic activity in the Uinta Basin. The area is in a period of tectonic quiescence but with intensive erosion working on the Uinta Mountains and the Uinta Basin (Crowley, 1957, p. 29).

# ECONOMIC GEOLOGY

## General Statement

Economic potential of the Currant Creek Formation includes bituminous sandstones and petroleum. Coal is an important economic resource of the Mesaverde Formation.

## Bituminous Sandstones

Small deposits of bituminous sandstone occur in the Currant Creek and Uinta (?) Formations in secs. 16 and 17, T. 1 S., R. 7 W., in Duchesne County, about two and one-half miles northeast of Tabiona.

The bitumen saturation of the Currant Creek appears to be fairly heavy in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 16, T. 1 S., R. 7 W. The saturated zone extends from the bottom of a small steep wash to the upper contact with the Uinta (?) Formation on the north-facing slope of a steep ridge. The saturated zone is estimated to be about 100 feet thick. The sandstone is black, weathering to bluish-gray, is coarse-grained, and the grains are angular. Some pebbles and granules of gray quartzite and black chert are included in the sandstone.

The saturation in the Uinta (?) Formation is less intense than that in the Currant Creek. The saturated zone is located along the north-facing slope of a small ridge in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ and the SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 17 and in a small outlier in the SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 17. The saturation appears to be confined to a series of beds with saturation ranging from 15 to 21 feet thick. The sandstone is grayish-black, weathering bluish- to light-gray, is fine- to medium-grained, with subangular to subrounded grains of quartz. The beds range from 6 to 18 inches thick and dip southward about 26°. Bitumen saturation in this area had previously been noted by Covington (1963, p. 245 and 1964, p. 239).

## Petroleum

The Currant Creek Formation, being a series of conglomerates, sandstones, siltstones, and shales, may offer subsurface stratigraphic traps for oil accumulation. Changes in porosity between siltstone and sandstone or sandstone and conglomerate units may be suitable traps for oil. The Currant Creek dips steeply southward and it seems reasonable that oil migrating up dip northward from the Uinta Basin might be entrapped within. The Tabiona bituminous sandstones offer evidence of earlier petroleum migrations of this type.

The Uinta Basin Fault (fig. 19) may be a large trap for oil accumulations both on the upthrown and the downthrown sides. Oil migrating northward from the Uinta Basin may have accumulated against the downthrown side of the fault. Oil that may have accumulated in stratigraphic or structural traps prior to faulting may have been further enclosed by faulting. It would seem that extensive geophysical exploration in this area, to find deep-seated stratigraphic or structural traps, is warranted. Drilling depths for this type of exploration would be deep and expensive. Possible reservoir rocks for oil accumulation are the Weber Quartzite, Dakota Sandstone, Mesaverde Formation, and sandstone units within the Wasatch-Currant Creek Formations.

No drilling depths or target areas are proposed because of the lack of subsurface information. However, extensive geophysical exploration in this area is proposed with enthusiasm. There is every possibility that an oil field, comparable to the Phillips Petroleum Bridger Lake Field on the north flank of the Uintas, exists somewhere along the south flank of the Uintas near the South Flank Fault System or the Uinta Basin Fault.

## Coal

The coal resources of the Frontier Sandstone and the Mesaverde Formation of Cretaceous age have been studied in detail by Lupton, and reported in his Tabby Mountain Coal Field report (1912).

Limited development of the coal resources along Red Creek in the Frontier and Mesaverde have been attempted recently by the Red Creek Coal Company (Redding, 1966, personal communication).

## SUMMARY

The Currant Creek Formation of Late Cretaceous to Early Eocene age has been studied with the following results:

(1) The Currant Creek Formation is located on the southwest flank of the Uinta Mountains and on the northwest flank of the Uinta Basin.

(2) Three pediment terraces are expressed in the area and are tentatively referred to, from oldest to youngest, with descending elevation, the Lake Mountain terrace, Jensen terrace, and the Vernal or Thornburg strath terraces.

(3) The lower part of the Currant Creek Formation is predominantly sandstone and conglomerate and the upper part is predominantly sandstone, siltstone, and shale.

(4) Boulders and cobbles composed of sandstone and containing Cretaceous fossils were found in the Duchesne River-Little Valley areas.

(5) Local, thin bentonite layers weathering to "popcorn" surfaces may be interbedded in the Currant Creek Formation. These bentonites are probably not economic deposits at the present time.

(6) The Currant Creek Formation is probably an upper river flood-plain deposit that was deposited near the headwaters of the transporting stream.

(7) The junction area of the Wasatch and Uinta Mountains is proposed as a source area for Currant Creek sediments.

(8) The age of the Currant Creek Formation is placed as Late Cretaceous to Early Eocene.

(9) The Currant Creek Formation is correlated with the Bennion Creek, North Horn, Flagstaff, and Colton Formations of the Wasatch Plateau and the Wasatch Formation of the Uinta Basin and is tentatively correlated, in part, with the Echo Canyon and Knight Formations of the Wasatch Mountains. The correlation presented, however, follows those correlations suggested by Walton (1944 and 1964), Abbot (1957), and Murany (1963 and 1964).

(10) The Currant Creek Formation was deposited contemporaneously with the Late Cretaceous-Early Paleocene uplifts of the Uinta Mountains.

(11) Regionally and locally, all rocks in the area dip southward from more than $50^{\circ}$ to less than $5^{\circ}$.

(12) The Currant Creek Formation overlies the Mesaverde Formation disconformably and underlies the Uinta (?) Formation disconformably or with a slight angularity of up to $5^{\circ}$.

(13) A thrust fault, herein named the Uinta Basin Fault, may exist below the Uinta (?) Formation and was discovered by subsurface structure contour mapping. The fault follows the approximate axis of the Uinta Basin.

(14) The Uinta Basin Fault may offer grounds for extensive geophysical prospecting and drilling in the search for petroleum in the vicinity of the fault.

(15) Bituminous sandstone deposits are present in the Currant Creek and Uinta (?) Formations in the Duchesne River-Little Valley areas.

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# APPENDICES

Appendix A: Section one of Currant Creek Formation along Red Creek in Secs. 26 and 35, T. 1 S., R. 9 W., Uinta Special Meridian, Duchesne County, Utah.

Tertiary:

Uinta Formation: Sandstones and siltstones. Sandstones: light gray, weather light gray; fine- to medium-grained, subrounded to rounded grains; calcareous cement, thick-bedded (1 to 2 feet); composed of 98% quartz and 2% chert. Orthoquartzite. Interbedded with siltstones; reddish-brown, weathers reddish-brown; clayey; calcareous cement; thick- to very thick-bedded (1 to 5 feet); weathers to small pinnacles; contains bentonite weathering to "popcorn" surface. Clayey siltstone.

Unconformity.

Tertiary-Cretaceous:

| Currant Creek Formation: | Feet |
|---|---|
| 1. Slope; reddish sandy soil; contains chips, and blocks of Uinta Formation talus; contact with Uinta obscure . . . . . . . | 43 |
| 2. Slope; reddish clayey soil; covered with Bishop Conglomerate talus. Downslope is outcrop of sandstone; light gray; fine- to medium-grained; subangular to subrounded grains; fairly sorted; calcareous cement; friable . . . . . . . . . . . . | 12 |
| 3. Slope; reddish clayey sandy soil; Bishop Conglomerate talus . . . . . . . . . . | 155 |
| 4. Alluvium . . . . . . . . . . . . . . . . . . | 34 |
| 5. Slope; yellowish-brown to light gray sandy soil . . . . . . . . . . . . . . . . . . | 79 |

| | | |
|---|---|---|
| 6. | Sandstone and siltstone; variegated; sandstone, fine-grained; subrounded grains; well sorted; calcareous cement; friable; medium-bedded; interbedded with siltstone. Orthoquartzite . . | 5 |
| 7. | Slope; light yellowish-brown clayey sandy soil . | 41 |
| 8. | Sandstone; light gray, weathers light gray; fine- to medium-grained; angular to subrounded grains; light calcareous cement; friable; some grains frosted; medium-bedded (8 to 12 inches); composed of 94% quartz, 6% quartzite and other rock fragments, and a trace of glauconite. Protoquartzite. Large Cretaceous sandstone boulder as talus on outcrop . . . . . . . . . . . . . . . . . . | 14 |
| 9. | Slope; yellowish-gray to light reddish-brown sandy soil covered with Bishop and Uinta talus . . . . . . . . . . . . . . . . . . . . | 385 |
| 10. | Sandstone, light reddish-brown, weathers reddish gray; very fine- to coarse-grained; subangular to subrounded grains; poorly sorted; calcareous cement; somewhat friable; some grains frosted; medium-bedded (6 to 12 inches); composed of 92% quartz and chert and 8% quartzite and other rock fragments. Protoquartzite . . . . . . . . . . . . . . | 21 |
| 11. | Sandstone; light gray, weathers gray; fine- to medium-grained; subangular to subrounded grains; poorly sorted; calcareous cement; somewhat friable; medium-bedded (6 inches); beds poorly exposed; composed of 90% quartz and chert and 10% quartzite and other rock fragments. Protoquartzite . . . . . . . . . . | 15 |
| 12. | Slope; red clayey sandy soil . . . . . . . . . . | 70 |
| 13. | Alluvium . . . . . . . . . . . . . . . . . . . . | 20 |

| | | |
|---|---|---|
| 14. | Slope; red clayey sandy soil . . . . . . . . . . | 50 |
| 15. | Alluvium . . . . . . . . . . . . . . . . . . . . | 198 |
| 16. | Slope; red clayey sand soil . . . . . . . . . . | 20 |
| 17. | Sandstone; light yellowish-gray, weathers light gray; fine-grained; subangular to subrounded grains; well sorted; light calcareous cement; friable; medium-bedded (4 to 12 inches); interbeds of very thin-bedded (0.4 to 1 inch) sandstone; low angle cross-bedding prominent; composed of 99% quartz and 1% chert. Orthoquartzite . . . . . . . . . . . . . . . . . . . | 20 |
| 18. | Slope; reddish clayey sandy soil . . . . . . . . | 93 |
| 19. | Alluvium; approximately 240 feet from base of unit is a small hill protruding into alluvium. May be sandstone . . . . . . . . . . . . . . . | 290 |
| 20. | Conglomerate; light reddish-gray, weathers reddish-brown; framework of cobbles and pebbles with pebbles predominant; angular to subangular particles; fairly sorted. Voids with sandstone matrix; medium- to coarse-grained, angular grains; poorly sorted; calcareous cement; composed of 90% quartz and 10% quartzite and other rock fragments. Lithic (petromict) pebble conglomerate . . . | 25 |
| 21. | Sandstone; light gray, weathers light gray; fine- to coarse-grained; subangular to subrounded grains; poorly sorted; calcareous cement; some grains frosted; medium-bedded (4 to 8 inches); low angle cross-bedding prominent; composed of 90% quartz, 8% quartzite and other rock fragments, and 2% pink chert. Protoquartzite . . . . . . . . . | 4 |
| 22. | Slope; sandy soil . . . . . . . . . . . . . . . | 40 |

23. Alluvium . . . . . . . . . . . . . . . . . . . . . 115

24. Sandstone; light gray, weathers light gray; fine- to coarse-grained; angular to subrounded grains; poorly sorted; calcareous cement; massive-bedded; grades upward into medium-grained sandstone; composed of 85% quartz and chert and 15% quartzite and other rock fragments. Protoquartzite . . . . . . . . . . . . . . . . 10

25. Slope; sandy soil covered with Bishop and Currant Creek talus . . . . . . . . . . . . 10

26. Sandstone; yellowish-white, weathers yellowish-gray; very fine- to medium-grained; subangular to subrounded grains; poorly sorted; calcareous cement; friable; some grains frosted; massive-bedded; low angle cross-bedding; pebbly in places; composed of 93% quartz, 6% quartzite and other rock fragments, and 1% chert. Protoquartzite . 3

27. Conglomerate; light reddish-gray, weathers dark reddish-gray; framework of cobbles, pebbles, and granules; cobbles subangular to rounded; other particles subangular; graded bedding; cobbles lower 13.5 feet, pebbles and granules upper 2.5 feet; particles composed of 60% Weber Quartzite, 35% Cretaceous sandstone, 4% limestone of unknown age, and 1% red chert; disoriented. Voids with sandstone matrix; fine- to coarse-grained; subangular grains; poorly sorted; calcareous cement. Lithic (petromict) cobble conglomerate . . . . . . . . . . . . 16

28. Slope; red sandy soil . . . . . . . . . . . . 40

29. Conglomerate; light gray, weathers light yellowish-gray; framework of pebbles, granules, and some clay gall material; cobbles average

2 by 3 inches in size, pebbles and granules of all sizes; subangular to subrounded particles; poorly sorted; graded bedding; grades upward into pebble conglomerate. Voids with sandstone matrix; medium- to coarse-grained; subangular to subrounded grains; poorly sorted; calcareous cement. Lithic (petromict) pebble cobble conglomerate . . . . . . . . . . . . . . . . . . . . . 9

30. Conglomerate; light gray, weathers light gray; framework of pebbles grading upward into cobbles; subrounded to rounded particles; fairly sorted; graded bedding; particles composed of 60% Weber Quartzite, 33% Cretaceous sandstone, 7% Mississippian-Pennsylvanian black chert, and a trace of Paleozoic limestone. Voids with sandstone matrix; same as unit 29 . . . . . . . . . . . 4

31. Sandstone; light greenish-yellow, weathers light gray; fine- to medium-grained; subrounded to rounded grains; poorly sorted; calcareous cement; limonite staining along bedding planes; some grains frosted; massive-bedded; unit thins rapidly eastward; gradational with overlying beds; composed of 85% quartz and chert and 15% quartzite and other rock fragments. Protoquartzite . . . . . . . . . . 6

32. Sandstone, light gray, weathers gray; fine- to medium-grained; subrounded grains; poorly sorted; calcareous cement; somewhat friable; some grains frosted; very thin-bedded (0.4 to 0.5 inches) becoming thinner near top of unit; coarser grained near top of unit and coarser grained along strike, grades westward into very coarse-grained sandstone and granule conglomerate; interbeds of cobble conglomerate; cobbles angular to rounded; fairly sorted; low angle cross-bedding; cobbles composed of rocks from Precambrian to Tertiary lithologies . . . 10

| | | |
|---|---|---|
| 33. | Conglomerate; light gray, weathers light gray; framework of cobbles, pebbles, and granules with cobbles and pebbles predominant; cobbles average 2 by 3 inches in size, pebbles and granules of all sizes; angular to subangular particles; poorly sorted; thick-bedded; unit pinches out westward into cobble conglomerate. Lithic (petromict) pebble granule conglomerate . . . . . . . . . . . . . . | 2 |
| 34. | Slope; reddish clayey sandy soil; contains bentonite weathering to "popcorn" surface . . | 190 |
| 35. | Conglomerate; yellowish-brown, weathers yellowish-brown; framework of boulders and cobbles, mostly cobbles; boulders 1.5 to 2.5 feet in diameter, cobbles average 3 by 8 inches in size; subrounded to rounded particles; fairly sorted; particles elliptical in shape; boulders composed of Cretaceous sandstone; cobbles composed of mostly Weber Quartzite with some Mutual Quartzite and Mississippian-Pennsylvanian black chert. Voids with sandstone matrix; calcareous cement; friable. Lithic (petromict) cobble conglomerate . . . . . . . . . . . . . . . . . | 70 |
| 36. | Slope; yellow to red clayey sandy soil . . . . . | 258 |
| 37. | Sandstone; light yellowish-brown, weathers light yellowish-brown; fine-grained; subrounded grains; well sorted; calcareous cement; very friable; light yellow limonite staining of grains; massive-bedded; composed of 98% quartz and chert and 2% quartzite and other rock fragments. Orthoquartzite . . . . . | 26 |
| 38. | Conglomerate; yellowish-brown, weathers light yellowish-brown; framework mostly cobbles with some pebbles; massive-bedded; same as unit 40 . . . . . . . . . . . . . . . . . . . . . | 20 |

39. Sandstone; light yellowish-brown, weathers light yellowish-brown; fine- to medium-grained; subrounded to rounded grains; fairly sorted; trace of calcareous cement; friable; grains frosted; light yellow limonite stain on grains; spotty red limonite in places; massive-bedded; contains thin lenses of pebble conglomerate; composed of 95% quartz and chert and 5% quartzite and other rock fragments. Orthoquartzite . . . . . . . 13

40. Conglomerate; yellowish-brown, weathers yellowish-brown; framework of cobbles interbedded with pebbles; cobbles subrounded to rounded, pebbles more subangular; fairly sorted; particles oriented northwest-southeast; grades upward into pebbly sandstone; sandstone tongues penetrate outcrop and thin westward. Voids with sandstone matrix; fine- to medium-grained, subrounded grains; fairly sorted; trace of calcareous cement; friable; streaky limonite staining, some staining dark brown to black. Lithic (petromict) cobble conglomerate . . . . . . . . . . . 15

41. Sandstone; yellowish-brown, weathers yellowish-brown; fine- to medium-grained; subangular grains; fairly sorted; calcareous cement; friable; grains frosted; yellow limonite staining on grains; massive-bedded. Orthoquartzite. . . 16

42. Conglomerate; yellowish-brown, weathers light yellowish-brown; contains interbedded pebble and cobble conglomerate; same as unit 40 . . 12

43. Sandstone; light yellowish-brown, weahters light yellowish-brown; very fine- to medium-grained; subangular grains; poorly sorted; trace of calcareous cement; friable; some grains frosted; light yellow limonite staining of grains; thick-bedded; unit thickens rapidly eastward; composed of 96% quartz, 3% quartzite and other rock fragments, and 2% chert. Orthoquartzite . . . . 2

44. Conglomerate; yellowish-brown, weathers light yellowish-brown; framework of cobbles and pebbles, mostly pebbles; cobbles near top and base of unit; sharp upper and lower contacts. Lithic (petromict) pebble conglomerate . . . . . 9

45. Sandstone; same as unit 43; thickens eastward, pinches out a few feet westward . . . . . . . . 1

46. Conglomerate; light yellowish-brown, weathers yellowish-brown; framework of cobbles and pebbles, mostly pebbles, angular to subrounded particles; fairly sorted; particles elliptical in shape; oriented northwest-southeast; composed of mostly Weber Quartzite with some Mississippian-Pennsylvanian black chert. Voids with sandstone matrix; same lithology as unit 47. Lithic (petromict) pebble conglomerate . . . . . . . . . . . . . 7

47. Sandstone; light yellowish-brown, weathers yellowish-brown; fine-grained, subangular grains; well sorted; light calcareous cement; friable; grains frosted; yellow limonite staining on grains; limonite staining along bedding planes; medium-bedded; composed of 97% quartz, 2% chert, and 1% quartzite and other rock fragments. Orthoquartzite . . . . . . . . 2

48. Conglomerate; yellowish-brown, weathers yellowish-brown; framework of cobbles and pebbles, mostly pebbles; cobbles predominate in center of unit; particles range from 1 to 3 inches in diameter; subangular to subrounded particles; fairly sorted; thick-bedded. Voids with sandstone matrix; same lithology as unit 47. Lithic (petromict) pebble conglomerate . . . . . 3

49. Conglomerate and sandstone; yellowish-brown, weathers yellowish-brown; framework of pebbles at base of unit, upper half of unit is graded from cobbles 2.5 inches in diameter to coarse sand; heavy limonite staining throughout . . . 2

50. Sandstone; light yellowish-brown, weathers light yellowish-brown; fine- to medium-grained; subangular to subrounded grains; fairly sorted; spotty calcareous cement; friable; yellow limonite staining on grains; thick-bedded. Orthoquartzite . . . . . . . . 1

51. Conglomerate; light yellowish-brown, weathers yellowish-brown; framework of cobbles and pebbles; disoriented; particles composed of Weber Quartzite and Mississippian-Pennsylvanian black chert. Voids with sandstone matrix; same lithology as unit 52 . . . . . . 0.5

52. Sandstone; light yellowish-brown, weathers light yellowish-brown; fine- to medium-grained; subangular to subrounded grains; fairly sorted; spotty calcareous cement; friable; yellow limonite staining on grains; thick-bedded. Orthoquartzite . . . . . . . . . . . . . . 3

53. Conglomerate; light yellowish-brown, weathers yellowish-brown; framework of cobbles and pebbles; same lithology as unit 55 . . . . . . 2

54. Sandstone; light yellowish-brown, weathers light yellowish-brown; massive-bedded; same lithology as unit 52 . . . . . . . . . . . . . . 6

55. Conglomerate; light yellowish-brown, weathers light yellowish-brown; framework of boulders, cobbles, and pebbles; mostly cobbles and pebbles; boulders range from 1.5 by 2 feet to 2 by 3 feet in size, one boulder 4 by 6 feet in size; cobbles range from 8 by 10 inches to 2 by 2 inches and average 3 by 5 inches in size; pebbles of all sizes; subrounded to rounded particles; fiarly sorted; percussion marks on most particles; framework material composed of mostly Weber Quartzite with some Mütual Quartzite, Mississippian-Pennsylvanian black chert, and Cretaceous sandstone, most

boulders are Cretaceous sandstone. Voids with sandstone matrix; same lithology as unit 56. Lithic (petromict) cobble pebble conglomerate . . . . . . . . . . . . . . . 9

56. Sandstone; light yellowish-brown, weathers light yellowish-brown; fine-grained; subangular to subrounded grains; well sorted; calcareous cement; friable; yellow limonite staining on grains; massive-bedded; low angle cross-bedding; unit becomes pebbly near top of outcrop; unconformable with overlying conglomerate, red limonite staining along contact; composed of 98% quartz, 1% chert, and 1% rock fragments. Orthoquartzite . . . . . . . . . . . . . . . 31

57. Conglomerate; light reddish-yellow, weathers yellowish-brown; framework of cobbles and pebbles, mostly cobbles; cobbles subrounded to rounded, pebbles subangular to rounded; fairly sorted; contains thin lenses of granule and pebble conglomerate, scattered clay galls; general disorientation of material; particles composed of mostly Weber Quartzite with some Mutual Quartzite and Mississippian-Pennsylvanian black chert, and a trace of green quartzite, Twin Creek Limestone (oolitic), and Shinarump Member of the Chinle Formation; most particles fractured, red limonite staining along fractures. Voids with sandstone matrix. Lithic (petromict) cobble conglomerate . . . . . . . . . . . . . . . 12.5

58. Sandstone; light yellow, weathers yellow; fine- to medium-grained; subrounded to rounded grains; fairly sorted; trace calcareous cement; friable; yellow limonite staining on grains; very thick-bedded; composed of 94% quartz, 5% black and pink chert, and 1% rock fragments. Orthoquartzite . . . . . . . . . . . . . . . 5

59. Slope; sandy soil covered with cobble gravel . 146

60. Alluvium . . . . . . . . . . . . . . . . . . . . 57

61. Sandstone; light gray, weathers dark light gray; fine- to medium-grained; subangular to subrounded grains; fairly sorted; calcareous cement; some grains frosted; yellow limonite staining in streaks, chlorite staining of some grains; medium-bedded (6 to 12 inches); composed of 85% quartz, 14% pink and black chert, and 1% rock fragments. Orthoquartzite . . . . . . . . . . . . . . . 35

62. Sandstone; reddish-brown, weathers red; very fine- to medium-grained; angular to rounded grains; poorly sorted; calcareous cement; some grains frosted; red limonite staining on grains and matrix; massive-bedded; composed of 80% quartz, 10% quartzite and other rock fragments, 8% black and red chert, 1% muscovite, and 1% dark altered mafic minerals. Protoquartzite . . . . . . . . . . . . . . . 37

63. Slope; dark reddish-brown sandy soil; contains loose blocks of sandstone, light yellowish-brown, weathers light yellowish-brown; very fine- to medium-grained; subangular to rounded grains; poorly sorted; calcareous cement; limonite staining of grains and cement; composed of 75% quartz, 20% quartzite and other rock fragments, and 5% black and pink chert. Protoquartzite . . . . . . . . . . . . . . . 114

64. Sandstone; light yellowish-brown, weathers light reddish-brown; fine- to medium-grained; subangular to subrounded grains; poorly sorted; calcareous cement; medium-bedded (4 to 6 inches); composed of 75% quartz and 25% quartzite and other rock fragments. Subgraywacke-protoquartzite . . . . . . . . . . . . 1

65. Sandstone and pebble conglomerate; light yellowish-gray, weathers yellowish-gray; pebbles and granules at base of unit; subangular to sub-

rounded particles; conglomerate grades upward into pebbly sandstone; graded bedding . . . . . . . . . . . . . . . . . . . . 21

66. Slope; sandy soil covered with sandstone talus . . . . . . . . . . . . . . . . . . . . 42

67. Sandstone; yellowish-brown, weathers light yellowish-brown; fine- to medium-grained; subangular to subrounded grains; fairly sorted; calcareous cement; limonite staining throughout; thin- to medium-bedded (2 to 6 inches); poorly exposed; composed of 75% quartz, 15% quartzite and other rock fragments, 9% pink and black chert, and 1% muscovite and chlorite. Protoquartzite . . . . . . . . . . . . . . . . 18

68. Sandstone; light yellowish-brown, weathers yellowish-gray; fine- to medium-grained; subangular to subrounded grains; fairly sorted; calcareous cement; some grains frosted; spotty limonite staining; thick-bedded; grains become more coarse near base of unit; cobble sandstone at base of unit; composed of 85% quartz, 10% quartzite and other rock fragments, and 5% pink and black chert. Protoquartzite . . . . . . 8

69. Slope, sandy soil covered with cobble and pebble gravel . . . . . . . . . . . . . . . . 30

70. Sandstone; light yellowish-gray, weathers light yellowish gray; medium-grained, subangular grains; well sorted; calcareous cement; friable; grains frosted; some limonite staining in patches; very thick-bedded; composed of 90% quartz, 8% quartzite and other rock fragments, 1% chert, and 1% micaceous rock fragments. Protoquartzite . . . . . . . . . . . . . . . . 4

71. Conglomerate; light yellowish-gray, weathers light yellowish-gray; framework of cobbles

and pebbles, mostly cobbles; cobbles average 3 by 5 inches in size, pebbles of all sizes; cobbles subrounded to rounded, pebbles subangular to subrounded; cobbles composed of Weber Quartzite with some Mutual Quartzite; pebbles composed of mostly Mississippian-Pennsylvanian black chert and quartzite as above; particles oriented northwest-southeast. Voids with sandstone matrix; same lithology as unit 70. Lithic (petromict) cobble conglomerate . . . . 37

72. Sandstone; light gray, weathers light gray; very fine- to medium-grained; subangular to subrounded grains; poorly sorted; calcareous cement; friable; massive-bedded; beds grade laterally eastward into cobble-pebble conglomerate displaying graded bedding from cobbles into sandstone. Sandstone bed pinches out westward; composed of 70% quartz (abundant vein quartz). 20% quartzite and other rock fragments, and 10% chert. Protoquartzite . . . . . . . . . . . . 2

73. Conglomerate; light reddish-brown, weathers yellowish-brown; framework of cobbles and pebbles, mostly cobbles; cobbles average 3 by 5 inches in size; subrounded to rounded particles; cobbles composed of mostly Weber Quartzite with some Mutual Quartzite, pebbles composed of Mississippian-Pennsylvanian black chert and quartzite as above. Voids with sandstone matrix; same lithology as unit 72 . . . . . . . . . . . . . . . . . 23

74. Slope, sandy soil; adjacent wash contains one foot thick sandstone outcrop at base of slope. Sandstone; light reddish-brown, weathers yellowish-brown; very fine- to medium-grained; subangular to subrounded grains; poorly sorted; calcareous cement; somewhat friable; spotty limonite staining; very thin-bedded (0.5 inch);

composed of 75% quartz, 20% quartzite and other rock fragments, and 5% chert. Protoquartzite . . . . . . . . . . . . . . . . 41

75. Sandstone; light reddish-brown, weathers yellowish-brown; fine- to medium-grained, subangular to subrounded grains; fairly sorted; calcareous cement; friable; limonite staining of grains; thin-bedded (3 inches); composed of 90% quartz, 8% quartzite and other rock fragments, and 2% chert, with a trace of muscovite. Protoquartzite . . . . . 2

76. Conglomerate; light reddish-brown, weathers light reddish-brown; framework of boulders, cobbles, and pebbles; mostly cobbles; boulders average 12 inches in diameter, cobbles average 6 inches in diameter, pebbles of all sizes; boulders subrounded; graded bedding pronounced near base of unit; larger particles aligned northwest-southeast; percussion marks 2 inches in diameter abundant; particles composed mostly of Weber Quartzite with some Mutual Quartzite and Mississippian-Pennsylvanian black chert, and a trace of vein quartz. Voids with sandstone matrix; same lithology as unit 78 . . . . . . . . . . . . . . . . . 35

77. Slope, sandy soil covered with cobble gravel . 50

78. Sandstone; light yellowish-gray, weathers light yellowish-brown; very fine- to medium-grained, mostly very fine-grained; subangular grains; fairly sorted; calcareous cement; limonite staining of grains and cement; thin-bedded (2 to 4 inches); composed of 65% quartz (10% of this is vein quartz), 25% quartzite and other rock fragments, and 10% chert with a trace of muscovite. Subgraywacke-protoquartzite . . . . . . . . . . 1

79. Sandstone; same lithology as unit 81 . . . . . 3

80. Conglomerate; light yellowish-gray, weathers light yellowish-brown; framework of cobbles and pebbles, mostly cobbles; cobbles composed of Weber Quartzite with some Mutual Quartzite, pebbles composed of mostly Mississippian-Pennsylvanian black chert with some Cretaceous sandstone; percussion marks, very large (1 to 2 inches). Voids with sandstone matrix; same lithology as unit 81. Lithic (petromict) cobble conglomerate . . . . . . . . . . . . . . . . 8

81. Sandstone; light yellowish-brown, weathers light yellowish-brown; very fine- to fine-grained; subangular to subrounded grains; fairly sorted; calcareous cement; thin-bedded (0.2 inches); unit thins rapidly eastward and thickens to about 15 feet westward where it is covered by talus; composed of 50% quartz (10% of this is vein quartz), 40% quartzite and other rock fragments, and 10% chert. Subgraywacke . . . . . . . . . . . . . . 7

82. Conglomerate; light yellowish-brown, weathers light yellowish-brown; framework of boulders, cobbles, and pebbles, mostly cobbles; cobbles average 6 by 8 inches in size; particles oriented about N 85$^{\circ}$ W and imbricated from 20$^{\circ}$ to 30$^{\circ}$ west; boulders and cobbles are Weber Quartzite, smaller cobbles and pebbles are Weber Quartzite and Mississippian-Pennsylvanian black chert; interbedded sandstone tongues from 1 to 2 feet thick pinch out westward. Voids with sandstone matrix; same lithology as unit 83. Lithic (petromict) cobble conglomerate . . . . . . . . . . . . . . . 32

83. Sandstone; light gray, weathers light yellowish-gray; very coarse-grained; angular to subangular grains; well sorted; calcareous cement; yellow limonite staining; very thick-bedded; in sharp contact with underlying beds;

composed of 50% vein and clear quartz and 50% quartzite and other rock fragments. Subgraywacke . . . . . . . . . . . . . . . . . . 4

84. Sandstone; reddish-brown, weathers light reddish-brown; fine- to medium-grained; subangular grains; poorly sorted; calcareous cement; friable; light yellow limonite staining on grains', dark brown limonite staining on cement; massive-bedded; low angle cross bedding; tongues of pebble and granule conglomerate pinch out eastward; graded bedding pronounced in conglomerate tongues; composed of 65% quartz and chert, 35% quartzite and other rock fragments, and a trace of muscovite. Subgraywacke . . . . . . 13

85. Conglomerate; light yellowish-gray, weathers yellowish-brown; same lithology as unit 88 . . 8

86. Slope, sandy soil covered with cobble gravel . . 47

87. Sandstone, light reddish-brown, weathers yellowish-brown; fine- to medium-grained; angular to subangular grains; poorly sorted; calcareous cement; some grains frosted; limonite staining throughout; composed of 65% quartz, 20% black chert, and 15% quartzite and other rock fragments. Subgraywacke . . . . . . . . . . . . . . 2

88. Conglomerate; light yellowish-gray, weathers yellowish-brown; framework of cobbles and pebbles, mostly cobbles; particles subrounded to rounded; particles oriented about N 80° W and imbricated about 30° west; thin lenses of pebble conglomerate characteristic; 8 feet up from base of unit is thin lense of sandstone 1.5 feet thick. Voids with sandstone matrix; fine- to coarse-grained; angular grains; poortly sorted; calcareous cement; composed of 50% quartz, 35% quartzite

and other rock fragments, and 15% chert. Lithic (petromict) cobble conglomerate. Sandstone lense; yellowish-gray, weathers yellowish-gray; fine- to medium-grained; angular to subangular grains; poorly sorted; trace calcareous cement; friable; yellowish- to reddish-yellow limonite staining on grains; composed of 65% quartz, 25% quartzite and other rock fragments, and 10% black chert. Subgraywacke . . . . . . . . . . . . . . . . . 32

89. Slope; sandy soil covered with cobble gravel . 33

90. Siltstone; light reddish-brown, weathers light reddish-brown; calcareous; dense; medium-bedded; nodular weathering surface; composed of 50-60% quartz siltstone, 30-40% very fine-grained sandstone, and 10% black chert. Sandy siltstone . . . . . . . . . . . . . . . . 2

91. Slope; sandy soil; covered with pebble gravel lower 48 feet . . . . . . . . . . . . . . 148

92. Sandstone; light reddish-brown, weathers yellowish-gray; medium- to coarse-grained; angular to subangular grains; fairly sorted; light calcareous cement; friable; light-yellow- to brownish-yellow limonite staining on grains; medium-bedded (8 inches); beds grade upward into pebble conglomerate; composed of 70% clear and vein quartz, 20% quartzite and other rock fragments, and 10% black chert. Subgraywacke-protoquartzite . . . . . . . . . . . . . . 1

93. Conglomerate; light yellowish-brown to gray, weathers light yellowish-brown to gray; framework of pebbles; pebbles 1.5 to 2 inches in diameter; subangular to subrounded pebbles; fairly sorted; composed of Mississippian-Pennsylvanian black chert and Weber Quartzite; outcrop poorly exposed. Voids with sandstone matrix;

medium-grained; subangular to subrounded grains; poorly sorted; calcareous cement. Lithic (petromict) pebble conglomerate . . . . 12

94. Slope; sandy soil covered with thin sandstone plates . . . . . . . . . . . . . . . . . . . 35

95. Sandstone; yellowish-brown, weathers yellowish-brown; very fine-grained; subrounded to rounded grains; fairly sorted; calcareous cement; friable; reddish-brown limonite staining throughout; thin-bedded (1.5 inches); beds poorly exposed; composed of 60% clear and vein quartz, 30% quartzite and other rock fragments, and 10% chert. Subgraywacke . . 31

96. Slope; sandy soil covered with cobble gravel; contains scattered conglomerate columns. Conglomerate; light yellowish-gray, weathers light yellowish-gray; framework of cobbles, pebbles, and granules; mostly cobbles; cobbles subrounded to rounded, pebbles subangular to rounded, granules angular to subangular; particles aligned approximately N 55$^{\circ}$ W. Voids with sandstone matrix; medium- to coarse-grained; subangular to subrounded grains; poorly sorted; calcareous cement; limonite staining along current bedding; massive-bedded; current beds 0.1 to 0.2 inches thick. Sandstone tongue one foot thick penetrates column, thins rapidly eastward. Lithic (petromict) cobble conglomerate . . . . . . . . . . . . . . . . 35

97. Slope, sandy soil covered with cobble gravel . 87

98. Sandstone; light gray, weathers light yellowish-gray; medium- to coarse-grained; angular to subangular grains; fairly sorted; light calcareous cement; friable; light yellow limonite staining on some grains; very thin-bedded (0.3 inch); poorly defined low angle cross-bedding; composed of 50% clear and vein quartz, 30% quartzite rock fragments,

10% dark rock fragments, and 10% black chert. Subgraywacke . . . . . . . . . . . . 6

99. Conglomerate; light yellowish-brown, weathers light yellowish-brown; framework of boulders, cobbles, and pebbles; mostly cobbles; cobbles average 8 by 12 inches in size; particles subrounded to rounded; fairly sorted; oriented approximately N 53° W; boulders and cobbles mostly Weber Quartzite with some Mutual Quartzite, pebbles primarily Mississippian-Pennsylvanian black chert. Voids with sandstone matrix; coarse- to very coarse-grained; angular grains; fairly sorted; calcareous cement. Lithic (petromict) cobble conglomerate . . . 20

100. Siltstone; reddish-brown; weathers light reddish-gray; calcareous; dense; dark reddish-brown limonite staining along bedding planes; laminated (0.1 inch); some dark reddish-brown limonite concretions; abundant plant debris; composed of 60% quartz siltstone and 40% sandstone, very fine-grained, composed of clear quartz and dark rock fragments. Sandy siltstone . . . . . . . . . . . . . . . . . 4

101. Conglomerate; light reddish-brown; weathers light reddish-brown; framework of cobbles and pebbles, mostly cobbles; cobbles of Weber Quartzite, pebbles of Weber Quartzite and Mississippian-Pennsylvanian black chert. Voids with sandstone matrix; same lithology as unit 99. Lithic (petromict) cobble conglomerate . . . . . . . . . . . . 7

102. Sandstone; light yellowish-gray, weathers light yellowish-gray; coarse-grained; angular grains; fairly sorted; calcareous cement; friable; medium-bedded (6 inches); interbedded with lenses of thin- to medium-bedded (3 to 12 inches) pebble and cobble conglomerate . . . . . . . . . . . . . . . . 7

103. Conglomerate; light gray to reddish-brown; weathers light yellowish-gray; framework of cobbles, pebbles, and granules; mostly pebbles; cobbles average 3 by 5 inches in size, pebbles average 1 inch in size, granules of all sizes; subrounded to rounded particles becoming more angular with decreasing size; larger particles elliptical in shape; cobbles and pebbles oriented northwest-southeast, imbricated 30 northwest; graded bedding, becomes finer and more sandy near top of unit; cobbles composed of Weber Quartzite; pebbles composed of Weber and Mutual Quartzite with abundant Mississippian-Pennsylvanian black chert. Voids with sandstone matrix; coarse-grained; angular grains; fairly sorted; light calcareous cement; friable. Lithic (petromict) pebble conglomerate . . . . . . . . . . . . . . . . . . 3

104. Slope; sandy soil covered with cobble and pebble gravel . . . . . . . . . . . . . . . . . . . . . . 74

Total Formation . . . . . . . . . . . . . . . . . . . . . . . . 3940 Feet

Unconformity.

Cretaceous:

Mesaverde Formation: Sandstone; grayish-white, weathers light reddish-gray; fine- to medium-grained; subangular to subrounded grains; fairly sorted; calcareous cement; dense; some grains frosted; contains scattered small pebbles and granules of quartzite and chert; coal-bearing in places; forms steep ledges; contact with overlying Currant Creek Formation obscure, chosen mainly on weathering resistance; Mesaverde resistant, Currant Creek partly nonresistant.

Appendix B: Section two of Currant Creek Formation near Duchesne River in Little Valley in the E$\frac{1}{2}$ Sec. 18, T. 1 S., R. 7 W., Uinta Special Meridian, Duchesne County, Utah.

Tertiary:

Uinta Formation: Conglomerate, sandstone, siltstone, mudstone, and shale. Conglomerate; light gray to gray; boulders, cobbles, pebbles, and granules; subangular to rounded particles; composed of lithologies from Precambrian to Cretaceous. Sandstone; light gray to grayish-red; fine- to coarse-grained; subangular to subrounded grains. Siltstone and mudstone; gray to grayish-green and grayish-red; calcareous. Shale; graish-green to red; calcareous; sandy; irregular bedding; lenses. Weathers into slopes and ledges; contains interbedded bentonites weathering to "popcorn" surfaces.

Unconformity.

Tertiary-Cretaceous:

| Currant Creek Formation: | Feet |
|---|---|
| 0. Alluvium; contains Uinta and Currant Creek talus. Unconformity above obscured by alluvium. | |
| 1. Conglomerate; light reddish-gray, weathers light reddish-gray; framework of boulders; boulders average 12 inches in diameter; boulders subrounded to rounded; boulders composed of Cretaceous sandstone. Voids with sandstone matrix; poorly exposed . . . . | 26 |
| 2. Slope; sandy soil . . . . . . . . . . . . . . | 22 |
| 3. Conglomerate; light reddish-gray, weathers light reddish-gray; framework of boulders; boulders average 12 inches in diameter; boulders subrounded to rounded; boulders | |

composed of Cretaceous sandstone; outcrop poorly exposed; boulders fossiliferous . . . . 8

4. Slope; sandy soil . . . . . . . . . . . . . . . . . 37

5. Sandstone; light yellowish-gray, weathers yellowish-gray; very fine- to fine-grained; subangular to subrounded grains; fairly sorted; calcareous cement; limonite staining in places; thin-bedded; trace of bone debris; composed of 95% quartz and 5% pink and black chert. Orthoquartzite . . . . 57

6. Sandstone; light gray, weathers light gray; fine-grained; subangular to subrounded grains; well sorted; calcareous cement; friable; light yellow limonite staining; very thin- to thin-bedded (0.2 to 0.5 inch); may contain bentonite weathering to "popcorn" surface; contains trace of asphaltic residue; composed of 97% quartz, 3% chert, and a trace of altered mafic minerals. Orthoquartzite . . . . . . . . . . . . . . . . 30

7. Sandstone; light gray, weathers light yellowish-gray; fine-grained; subangular to subrounded grains; well sorted; light calcareous cement; very friable; reddish-brown to red limonite dikes in fractures; light yellow limonite staining in places; medium-bedded (5 to 8 inches); may contain bentonite weathering to "popcorn" surface; composed of 96% quartz, 3% black chert, and 1% rock fragments. Orthoquartzite . . . . . . . . . . . . . . . . 38

8. Conglomerate; light yellowish-gray, weathers light yellowish-brown; framework of boulders, cobbles, and pebbles; mostly boulders and cobbles; boulders average 12 inches in diameter; boulders rounded, cobbles subrounded to rounded, pebbles subangular to subrounded; graded bedding, grades upward into cobbles and pebbles; boulders composed of Cretaceous sandstone as described in unit 13; boulders

fossiliferous; cobbles composed of Cretaceous sandstone with some Weber Quartzite, pebbles composed of Mississippian-Pennsylvanian black chert and some quartzite; particles disoriented. Voids with sandstone matrix; fine- to medium-grained; subangular to subrounded grains; fairly sorted; light calcareous cement; friable; composed of 98% quartz and 2% chert. Lithic (petromict) boulder-cobble conglomerate . . . . . . . . . . . . . . 15

9. Sandstone; light gray, weathers dark light gray; very fine- to fine-grained; subangular to subrounded grains; well sorted; light calcareous cement; somewhat friable; yellow- to yellowish-brown limonite staining in places; medium-bedded (6 inches); trace of asphaltic residue; composed of 96% quartz, 3% black chert, and 1% rock fragments. Orthoquartzite . . . . . . . . . . 13

10. Slope; sandy soil covered with Currant Creek talus . . . . . . . . . . . . . . . . . . . . . . 26

11. Conglomerate; light reddish-gray, weathers light reddish-gray; framework of boulders, cobbles, and pebbles; mostly cobbles and pebbles; boulders range from 1 to 3 feet in diameter, cobbles range from 6 to 12 inches in diameter, pebbles of all sizes; boulders and cobbles elliptical in shape; larger particles oriented approximately N 52 E; boulders and cobbles composed of Cretaceous sandstone as described in unit 13, fossiliferous; pebbles composed of quartzite and black chert . . . . . . . . . . 17

12. Slope; yellowish-brown sandy soil covered with large talus boulders from above; one boulder 3 by 5 feet in size . . . . . . . . . 21

13. Conglomerate; light reddish-gray, weathers light reddish-gray; framework of boulders, cobbles, and pebbles; mostly pebbles lower 12 feet of unit; cobbles and boulders at top of unit; boulders average 12 inches in diameter; boulders and cobbles subrounded to rounded, pebbles subangular to subrounded; graded bedding; larger particles oriented approximately N 70 W and N 70 E; boulders composed of Cretaceous sandstone, cobbles composed of Cretaceous sandstone and Weber Quartzite, pebbles composed of Weber Quartzite and Mississippian-Pennsylvanian black chert. Boulders are sandstone; yellowish-brown weather light yellowish-brown; fine-grained; subrounded to rounded grains; well sorted; calcareous cement; dense, light yellowish-brown limonite staining throughout; fossiliferous, fossils along preserved bedding planes; abundant dendrites; composed of 96% quartz, 3% dark rock fragments, and 1% pink chert. Voids with sandstone matrix; fine-grained; subangular to subrounded grains; well sorted; calcareous cement; friable; light yellow limonite staining on grains; composed of 96% quartz, 3% dark rock fragments; and 1% pink chert. Lithic (petromict) boulder-cobble conglomerate . . . . . . . . . . . . . . 27

14. Slope; reddish clayey sandy soil; contact with overlying conglomerate obscure, chosen where red soil grades into reddish-brown soil covered with talus from above. Sandy shale or sandy siltstone . . . . . . . . . . . 16

15. Sandstone; light gray, weathers light reddish-gray; fine- to medium-grained; subangular to rounded grains; fairly sorted; calcareous cement; somewhat friable; very thin-bedded (0.2 inch); composed of 98% quartz and 2% pink and black chert. Orthoquartzite . . . 2.5

16. Conglomerate; light gray, weathers light yellowish-gray; framework of pebbles and granules, mostly pebbles; pebbles average 0.2 to 0.5 inches in diameter, granules of all sizes; pebbles subangular to subrounded, granules angular to subangular; graded bedding, grades upward into sandstone. Voids with sandstone matrix; fine- to medium-grained; subangular to subrounded grains; poorly sorted; calcareous cement; light yellow to reddish-brown limonite staining on grains. Lithic (petromict) pebble-granule conglomerate . . . 2.5

17. Conglomerate; light gray, weathers light yellowish-gray; same lithology as unit 16; graded bedding; contacts with upper and lower units sharp . . . . . . . . . . . . . 2

18. Sandstone; light gray, weathers dark gray; medium-grained; subangular to subrounded grains, some rounded grains; light calcareous cement; friable; thick-bedded; low angle cross-bedding poorly exposed; contains scattered pebbles and granules; composed of 98% quartz, 1% pink chert, and 1% black chert. Orthoquartzite . . . . . . . . . . . 1.5

19. Conglomerate; light gray, weathers yellowish-gray; framework of small pebbles and granules, mostly granules; angular to subrounded particles; thick-bedded; grades upward into sandstone. Voids with sandstone matrix; fine- to coarse-grained; subangular to subrounded; poorly sorted; calcareous cement; composed of 97% quartz and 3% pink and black chert. Lithic (petromict) pebble-granule conglomerate . . . . . . . . . . . . . . . 2.5

20. Sandstone; light gray, weathers light gray; fine- to coarse-grained; subangular to subrounded grains; poorly sorted; calcareous cement; friable; very thin-bedded (0.3 inch); grades

upward into pebble conglomerate; composed of 96% quartz and 4% chert. Orthoquartzite . . . . . . . . . . . . . . . . . 4

21. Slope; sandy clayey soil, may be silty shale as below . . . . . . . . . . . . . . . . . . . . . . 34

22. Shale; light reddish-gray, weathers reddish-brown; calcareous; contains much sand and siltstone; fibrous satin spar chips scattered on surface; deeply weathered; contains bentonite weathering to "popcorn" surface. Sandy silty shale . . . . . . . . . . . . . . 20

23. Slope; light yellowish- to reddish-gray sandy soil; contains some thin beds of sandstone as described in unit 24; probably sandstone grading upward into siltstone and shale . . . 18

24. Sandstone; light yellowish-gray, weathers light reddish-gray; fine- to medium-grained; subangular grains; fairly sorted; calcareous cement; composed of 96% quartz and 4% chert. Orthoquartzite, grades upward into conglomerate; mostly granules upper 4 feet of unit; pebbles average 0.2 inch, granules of all sizes; subangular to angular particles; particles composed of quartzite and black chert with minor amounts of Cretaceous sandstone; very thin- to medium-bedded (0.3 to 12 inches), mostly medium-bedded (0.5 inch); pebble and granule conglomerate thins rapidly eastward and westward, lenticular . . . . . . . . . . . . . . . . . . . 32

25. Sandstone; light gray, weathers light reddish-gray; very fine- to medium-grained; subangular to subrounded grains; poorly sorted; calcareous cement; friable; massive-bedded with low angle cross-bedding; light limonite staining in places; thin lenses of pebble conglomerate and pebbly sandstone common;

unit grades upward into very thin-bedded sandstone; composed of 95% quartz, 3% pink chert, and 2% black chert, and a trace of green quartzite. Orthoquartzite . . . 10

26. Sandstone; light gray, weathers light gray; fine- to medium-grained, mostly fine-grained; subrounded to rounded grains; fairly sorted; calcareous cement; friable; many grains frosted; very thin-bedded (0.2 inch); grades upward into massive-bedded sandstone; some limonite staining around dark minerals; composed of 90% quartz, 7% pink chert, 2% black chert, 1% quartzite, and a trace of dark mafic minerals. Orthoquartzite . . . . . . . . . . 4.5

27. Conglomerate; light gray, weathers light gray; framework of very small pebbles and granules; pebbles and granules subangular; thin-bedded (2 inches); grades upward into very thin-bedded sandstone; particles composed of gray quartzite and black chert. Voids with sandstone matrix; fine- to very coarse-grained; subangular to subrounded grains; poorly sorted; calcareous cement; somewhat friable; some light yellow- to light reddish-brown limonite staining of grains; composed of 95% quartz and 5% black chert. Lithic (petromict) granule-pebble conglomerate . . . . . . . . . 3.5

28. Slope; reddish sandy soil . . . . . . . . . . . 5

29. Sandstone; light gray, weathers light gray; very fine- to fine-grained; subrounded to rounded grains; fairly sorted; calcareous cement; friable; some grains frosted; very thin- to laminated-bedding (0.1 inch); some poorly defined cross-bedding; composed of 96% quartz, 2% pink chert, and 2% black chert. Orthoquartzite . . . . . . . . . . . 7

30. Sandstone; light gray, weathers light reddish-gray; fine- to coarse-grained; subangular to subrounded grains; poorly sorted; calcareous cement; friable; thick-bedded; contains much small pebble and granule material composed of angular quartzite; composed of 92% quartz, 4% quartzite and other rock fragments, and 4% pink and black chert. Orthoquartzite . . . . . . . . . . . . . . . . 2.5

31. Shale; reddish-brown, weathers light reddish-brown; calcareous; silty; much very fine- to fine-grained quartz sand; deeply weathered; contains bentonite weathering to "popcorn" surface. Silty sandy shale . . . . . . 38

32. Sandstone; light gray, weathers light gray; fine- to medium-grained; subangular to subrounded grains; fairly sorted; light calcareous cement; friable; thin- to massive-bedded; contains lenses of pebble and granule conglomerate; pebbly; composed of 95% quartz, 3% pink chert, and 2% rock fragments. Orthoquartzite . . . . . . . 30

33. Sandstone; mostly slope; obscure outcrop . . . 35

34. Sandstone; light gray, weathers light gray; very fine- to medium-grained; subangular grains; poorly sorted; calcareous cement; somewhat friable; massive-bedded; pebbly; pebbles average 0.2 inches in diameter; pebbles angular and composed of quartzite; some granules of quartzite and black chert; composed of 90% quartz, 5% quartzite rock fragments, and 5% pink and black chert. Protoquartzite-orthoquartzite . . . . . . . 25

35. Conglomerate and pebbly sandstone; light gray, weathers light gray; framework of very small pebbles and granules; pebbles and granules predominantly quartzite with some black chert

and Cretaceous sandstone; somewhat oriented northwest–southeast, otherwise disarranged; massive-bedded; poorly defined low angle cross-bedding; calcareous cement; friable . . . . . . . . . . . . . . . 25

36. Slope; sandy soil . . . . . . . . . . . . . . . . . . 75

37. Sandstone; light gray, weathers light gray; very fine- to medium-grained; subangular to subrounded grains; fairly sorted; calcareous cement; friable; thin- to medium-bedded (3 to 6 inches); composed of 95% quartz, 3% pink and black chert, and 2% rock fragments . . . . . . . . . . . . . . . . . . 35

38. Siltstone and silty shale; light reddish-brown to reddish-gray, weathers light reddish-gray; slightly calcareous; contains some very fine-grained subangular to subrounded quartz grains; contains bentonite weathering to "popcorn" surface. Sandy silty shale and siltstone . . . . . . . . . . . . . . . . . 49

39. Sandstone; light yellowish-red, weathers yellowish-brown; fine- to medium-grained; subangular to rounded grains; fairly sorted; very light siliceous cement; many grains frosted; yellowish-red limonite staining on grains; fractures across grains; massive-bedded; contains lenses of pebble-granule conglomerate and scattered pebbles and granules in sandstone; composed of 96% quartz and 4% rock fragments. Orthoquartzite. . . . . . . . . . . . . . . . . . 35

40. Slope; reddish-brown to white sandy soil . . . 55

41. Sandstone; light gray, weathers dark gray; fine- to medium-grained; subangular to subrounded grains; poorly sorted; calcareous cement; somewhat friable; thick-bedded (2 feet); concretions, 0.1 to 0.2 inch in diameter, same material as host

rock, haloes up 0.1 inch wide of dark limonite stain around concretions, soft, in early stage of development; contains scattered large granules and very small pebbles; composed of 85% quartz, 8% rock fragments, and 5% pink and black chert. Protoquartzite . . . . 30

42. Slope; sandy soil . . . . . . . . . . . . . . . 33

43. Sandstone; light yellowish-gray, weathers yellowish-gray; same lithology as unit 45 . 6

44. Conglomerate and pebbly sandstone; light yellowish-gray, weathers yellowish-gray; framework of small pebbles and granules; pebbles and granules composed of gray quartzite and black and pink chert; very thick-bedded. Voids with sandstone matrix; fine- to coarse-grained; subangular to subrounded grains; poorly sorted; calcareous cement. Lithic (petromict) pebble-granule conglomerate . . . . . . . . . . . 4

45. Sandstone; light yellowish-gray, weathers yellowish-gray; fine- to medium-grained; angular to subangular grains; fairly sorted; calcareous cement; light yellow- to yellowish-red limonite staining of grains; contains pebble conglomerates in channels up to 2 feet thick; channels pinch out rapidly east and west along strike; stringers of pebbles and granules persistent throughout unit; massive-bedded; low angle cross-bedding poorly defined; sandstone composed of 70% quartz, 20% quartzite and other rock fragments, 10% chert, and a trace of bornite?. Protoquartzite . . . . . . . . . . . . . . 103

46. Slope; reddish clayey sandy soil . . . . . . . . 3.5

47. Sandstone; light gray, weathers light gray; very fine- to medium-grained; subrounded to rounded grains; poorly sorted; calcareous cement; dense; massive-bedded; low angle cross-bedding; rhombic fracturing; some asphaltic residue, fluorescent; composed of 90% quartz, 7% rock fragments, and 3% pink and black chert. Protoquartzite . . . . . 10

48. Slope; reddish-brown silty soil . . . . . . . . . 19

49. Sandstone; light yellowish-gray, weathers yellowish-gray; fine- to medium-grained; subrounded to rounded grains; fairly sorted; calcareous cement; light yellow limonite staining on grains; rhombic fracturing, fractures filled with light gray fine- to medium-grained quartz sandstone; massive-bedded; low angle cross-bedding; composed of 95% quartz, 3% chert, 2% rock fragments, and a trace of obsidian. Orthoquartzite . . . 25

50. Slope; sandy soil . . . . . . . . . . . . . . . . . 6.5

51. Sandstone; light yellowish-brown, weathers yellowish-brown; very fine- to fine-grained; subangular to subrounded grains; poorly sorted; light calcareous cement; friable; medium- to massive-bedded (0.5 to 6 feet); rhombic fracturing, rhombs 6 by 12 inches in size; fractures filled with white calcite; composed of 95% quartz, 3% chert, and 2% rock fragments. Orthoquartzite . . . . . . 17

52. Siltstone; light gray, weathers reddish-brown; calcareous; contains abundant fine- to medium-grained quartz sand; contains bentonite weathering to "popcorn" surface; reddish-brown oxidized zone lower 7 feet of unit . . . . . . . . . . . . . . . . . . 23

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| 53. | Sandstone; light yellowish-gray, weathers yellowish-brownish-gray; fine- to medium-grained; subrounded to rounded grains; poorly sorted; calcareous cement; some grains frosted; limonite staining in streaks and spots; thick-bedded (1 foot); slight trace of green copper staining . . . . . . . . . | 5 |
| 54. | Slope; red clayey sandy soil; deeply weathered . | 62 |
| 55. | Sandstone; light yellowish-brown, weathers yellowish-brown; medium- to coarse-grained; subangular to angular grains; fairly sorted; calcareous cement; limonite staining throughout; thin- to thick-bedded (1 to 12 inches), grades upward into thick beds; grades upward into pebbly sand and pebble conglomerate upper 2.5 feet of unit; composed of 65% quartz and chert and 35% quartzite and other rock fragments. Subgraywacke . . . | 7 |
| 56. | Slope; sandy clayey soil; covered with talus from above; contains bentonite weathering to "popcorn" surface . . . . . . . . . . . . . | 30 |
| 57. | Sandstone; mostly slope with reddish-brown sandy soil and sandstone talus blocks from below; upper 5 feet of unit is same lithology as unit 58; medium- to thick-bedded (6 to 24 inches) . . . . . . . . . . . . . . . . . . . . | 29 |
| 58. | Sandstone; variable gradational lithologies. Lower part of unit is sandstone; light yellowish-gray, weathers reddish-brown; very fine- to fine-grained; subrounded to rounded grains; poorly sorted; calcareous cement; dense; light yellow limonite staining on grains; medium-bedded (6 inches); composed of 80% quartz, 15% rock fragments, and 5% chert. Grades upward into very fine-grained sandstone; subrounded to rounded grains; well sorted; calcareous and bentonitic cement; | |

limonite staining throughout; medium-bedded (6 inches); composed of 90% quartz and chert and 10% rock fragments. Grades upward into coarse-grained sandstone; angular to subangular grains; well sorted; calcareous cement; medium-bedded (6 inches); composed of 55% clear and vein quartz, 40% quartzite and other rock fragments, 4% pink and black chert, 1% green quartzite, and a trace of hemetite. Grades upward into medium-grained sandstone of same lithology; some asphaltic residue. Fracturing perpendicular to strike throughout outcrop. Subgraywacke-protoquartzite . . . 49

59. Sandstone; light yellowish-gray, weathers yellowish-gray to light gray; medium- to coarse-grained; angular to subangular grains; fairly sorted; calcareous cement; limonite staining throughout; reddish-brown limonite staining in places; massive-bedded; cross-bedding, angles of 30° between cross-beds; stringers and lenses of granule and pebble conglomerate and lenses of reddish-brown medium-grained sandstone; composed of 50% quartz, 45% quartzite and other rock fragments, 4% pink and black chert, and 1% green quartzite. Subgraywacke . . . . . . . . 17

60. Siltstone and shale; light gray, weathers light reddish-gray, variecolored in places; calcareous; sandy; contains bentonite weathering to "popcorn" surface . . . . . . . . . . . 19

61. Sandstone; light yellowish-brown, weathers light yellowish-brown; very fine- to fine-grained; subrounded to rounded grains; fairly sorted; calcareous and bentonitic cement; limonite staining in places; medium-bedded (8 inches); composed of 85% quartz and chert and 15% quartzite and other rock fragments. Protoquartzite . . . . . . . . . . . . . . . . . . . 1.5

62. Sandstone; light reddish-gray, weathers reddish-brown; fine-grained; angular to subangular grains; fairly sorted; calcareous cement; dense; limonite staining throughout; thick-bedded; grades upward into a 6 inch bed of soft siltstone; composed of 90% quartz and 10% rock fragments . . . . . . . . . . . . . . 1.5

63. Siltstone; light grayish-red, weathers reddish-brown; calcareous; contains 25% very fine- to fine-grained quartz sand; very thick-bedded . . . . . . . . . . . . . . . . . . . 5

64. Siltstone; light reddish-brown, weathers yellowish-brown; calcareous; contains abundant very fine- to fine-grained quartz sand; very thin-bedded (0.3 to 0.4 inch); corrugated weathering surface; current ripple marks, wave lengths range from 2 to 7 inches and average 2 inches; rib-and-furrow structures predominant, indicate diversified current directions; current directions average S 81 E; some poorly defined low angle cross-bedding. Sandy siltstone . . . . . . . . . . . . . . . 2.5

65. Shale; gray, weathers light gray; calcareous; silty; some limonite staining; weathers into thin plates; contains bentonite weathering to "popcorn" surface; deeply weathered. Silty shale . . . . . . . . . . . . . . . 12

66. Sandstone; light yellowish-gray, weathers light yellowish-gray; fine- to medium-grained; angular to subangular grains; fairly sorted; calcareous cement; thin- to thick-bedded (3 to 36 inches); thin beds finer-grained and more uniform in composition; composed of 55% quartz, 40% quartzite and other rock fragments, and 5% chert. Subgraywacke . . . . . . . . . . . . . . . 15

67. Siltstone; reddish-brown, weathers reddish-brown; calcareous; streaks of yellow limonite staining; forms red soil zone; mostly slope . . . . . . . . . . . . . . . . . . 19

68. Sandstone; light yellowish-brown, weathers light yellowish-brown; very fine- to fine-grained; subrounded to rounded grains; poorly sorted; calcareous cement; very thin-bedded (0.4 to 0.5 inch); some poorly defined low angle cross-bedding . . . . . . . 3

69. Slope; sandy soil; covered with manganese concretions and plates . . . . . . . . . . . . . 3.5

70. Sandstone; light yellowish-gray, weathers yellowish-gray; medium-grained; angular to subangular grains; fairly sorted; calcareous cement; heavy limonite staining throughout; composed of 80% quartz, 20% quartzite and other rock fragments, and 1% vein quartz. Protoquartzite . . . . . . . . . 3.5

71. Sandstone; light gray, weathers whitish-gray; medium-grained; angular to subangular grains; fairly sorted; calcareous cement; friable; massive-bedded; grades upward into yellower beds; composed of 85% clear and vein quartz and 15% rock particles. Protoquartzite . . . . . . . . . 7

72. Slope, sandy soil covered with talus blocks from above . . . . . . . . . . . . . . . . . . 21

73. Sandstone; light gray, weathers yellowish-gray; fine-grained; angular to subangular grains; well sorted; calcareous cement; medium-bedded (6 to 12 inches); grades downward into graded sandstone sequence . . 15

74. Sandstone; light gray, weathers yellowish-gray; fine- to coarse-grained; angular to rounded grains; poorly sorted; calcareous cement; some rounded grains frosted.

Grades upward into fine- to medium-grained sandstone; subangular to rounded grains; fairly sorted; calcareous cement; friable. Grades upward into fine-grained sandstone; subangular to subrounded grains; well sorted; calcareous cement. Entire unit dense; graded bedding; composed of 95% quartz, 4% chert, and 1% rock fragments. Orthoquartzite . . . . . . . . . . . . . . . . . . 20

Total Formation . . . . . . . . . . . . . . . . . . . . . . 1534 Feet

Unconformity.

Cretaceous:

Mesaverde Formation: Sandstone; light gray to white, weathers yellowish-gray; fine- to medium-grained; subangular to rounded grains; well sorted; calcareous cement; dense to friable in places; forms resistant ledge; fossiliferous in places; contact with overlying Currant Creek Formation obscure, chosen at the first occurrance of graded sediments in sandstone sequence; small graded unconformity between Currant Creek and Mesaverde Formations; composed of 95 to 97% quartz; 2 to 3% pink chert, and 1 to 2% rock fragments. Orthoquartzite.